

**Cell 1 Regional Coastal Monitoring Programme  
Analytical Report 10: 'Full Measures' Survey 2017**

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Authors	
Emma Hick	Royal HaskoningDHV
Dr Nick Cooper – Review	Royal HaskoningDHV
Dr Nick Cooper – Approval	Royal HaskoningDHV

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## Abbreviations and Acronyms

Acronym / Abbreviation	Definition
AONB	Area of Outstanding Natural Beauty
DGM	Digital Ground Model
HAT	Highest Astronomical Tide
LAT	Lowest Astronomical Tide
MHWN	Mean High Water Neap
MHWS	Mean High Water Spring
MLWS	Mean Low Water Neap
MLWS	Mean Low Water Spring
m	Metres
ODN	Ordnance Datum Newlyn

## Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (m AOD)			
	River Tyne to Frenchman's Bay	Frenchman's Bay to Souter Point	Souter Point to Chourdon Point	Chourdon Point to Hartlepool Headland
1 in 200 year	3.41	3.44	3.66	3.91
HAT	2.85	2.88	3.18	3.30
MHWS	2.15	2.18	2.48	2.70
MLWS	-2.15	-2.12	-1.92	-1.90

Water Level Parameter	Water Level (m AOD)			
	Hartlepool Headland to Saltburn Scar	Skinningrove	Hummersea Scar to Sandsend Ness	Sandsend Ness to Saltwick Nab
1 in 200 year	3.87	3.86	4.1	3.88
HAT	3.25	3.18	3.15	3.10
MHWS	2.65	2.68	2.65	2.60
MLWS	-1.95	-2.13	-2.15	-2.20

**Source:** *River Tyne to Flamborough Head Shoreline Management Plan 2.*  
Royal Haskoning, February 2007.

## Glossary of Terms

Term	Definition
Beach nourishment	Artificial process of replenishing a beach with material from another source.
Berm crest	Ridge of sand or gravel deposited by wave action on the shore just above the normal high water mark.
Breaker zone	Area in the sea where the waves break.
Coastal squeeze	The reduction in habitat area which can arise if the natural landward migration of a habitat under sea level rise is prevented by the fixing of the high water mark, e.g. a sea wall.
Downdrift	Direction of alongshore movement of beach materials.
Ebb-tide	The falling tide, part of the tidal cycle between high water and the next low water.
Fetch	Length of water over which a given wind has blown that determines the size of the waves produced.
Flood-tide	Rising tide, part of the tidal cycle between low water and the next high water.
Foreshore	Zone between the high water and low water marks, also known as the intertidal zone.
Geomorphology	The branch of physical geography/geology which deals with the form of the Earth, the general configuration of its surface, the distribution of the land, water, etc.
Groyne	Shore protection structure built perpendicular to the shore; designed to trap sediment.
Mean High Water (MHW)	The average of all high waters observed over a sufficiently long period.
Mean Low Water (MLW)	The average of all low waters observed over a sufficiently long period.
Mean Sea Level (MSL)	Average height of the sea surface over a 19-year period.
Offshore zone	Extends from the low water mark to a water depth of about 15 m and is permanently covered with water.
Storm surge	A rise in the sea surface on an open coast, resulting from a storm.
Swell	Waves that have travelled out of the area in which they were generated.
Tidal prism	The volume of water within the estuary between the level of high and low tide, typically taken for mean spring tides.
Tide	Periodic rising and falling of large bodies of water resulting from the gravitational attraction of the moon and sun acting on the rotating earth.
Topography	Configuration of a surface including its relief and the position of its natural and man-made features.
Transgression	The landward movement of the shoreline in response to a rise in relative sea level.
Updrift	Direction opposite to the predominant movement of longshore transport.
Wave direction	Direction from which a wave approaches.
Wave refraction	Process by which the direction of approach of a wave changes as it moves into shallow water.

## Preamble

The Cell 1 Regional Coastal Monitoring Programme covers approximately 300km of the north east coastline, from the Scottish Border (just south of St. Abb's Head) to Flamborough Head in East Yorkshire. This coastline is often referred to as 'Coastal Sediment Cell 1' in England and Wales (Figure 1). Within this frontage the coastal landforms vary considerably, comprising low-lying tidal flats with fringing salt marshes, hard rock cliffs that are mantled with glacial sediment to varying thicknesses, softer rock cliffs and extensive landslide complexes.

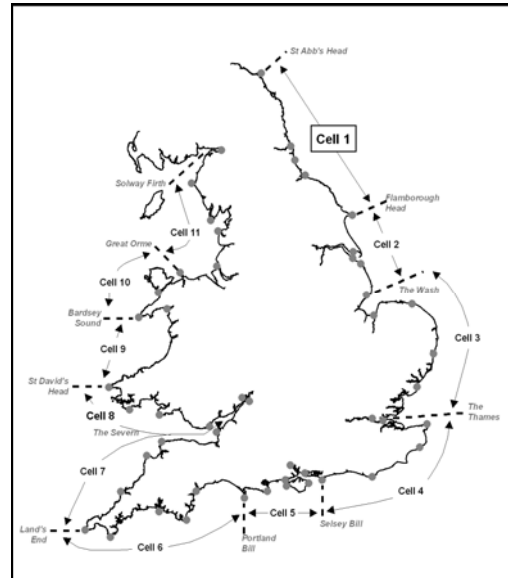


Figure 1 Sediment Cells in England and Wales

The work commenced with a three-year monitoring programme in September 2008 that was managed by Scarborough Borough Council on behalf of the North East Coastal Group. This initial phase has been followed by a five-year programme of work, which started in October 2011. The work is funded by the Environment Agency, working in partnership with the following organisations:



The main elements of the Cell 1 Regional Coastal Monitoring Programme involve:

- beach profile surveys
- topographic surveys
- cliff top recession surveys
- real-time wave data collection
- bathymetric and sea bed characterisation surveys
- aerial photography
- walk-over surveys

The beach profile surveys, topographic surveys and cliff top recession surveys are undertaken as a 'Full Measures' survey in autumn/early winter every year. Some of these surveys are then repeated the following spring as part of a 'Partial Measures' survey.

Each year, an Analytical Report is produced for each individual authority, providing a detailed analysis and interpretation of the 'Full Measures' surveys. This is followed by a brief Update Report for each individual authority, providing ongoing findings from the 'Partial Measures' surveys.

Annually, a Cell 1 Overview Report is also produced. This provides a region-wide summary of the main findings relating to trends and interactions along the entire Cell 1 frontage. To date the following reports have been produced:

**Table 1 Analytical, Update and Overview Reports Produced to Date**

Year		Full Measures		Partial Measures		Cell 1 Overview Report
		Survey	Analytical Report	Survey	Update Report	
1	2008/09	Sep-Dec 08	May 09	Mar-May 09		-
2	2009/10	Sep-Dec 09	Mar 10	Feb-Mar 10	Jul 10	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 11	Sep 11
4	2011/12	Sep-Oct 11	Oct 12	Mar-May 12	Feb 13	-
5	2012/13	Sep 12	Feb 13	Apr 13	May 13	-
6	2013/14	Sep-Oct 13	Feb 14	Mar 14	Jul 14	
7	2014/15	Sep-Oct 14	Feb 15	Apr 15	Jun 15	
8	2015/16	Aug 15	Feb 16	Apr 16	Jul 16	Jun 16
9	2016/17	Aug-Sep 16	Feb 17	Apr 17	Jul 17	
10	2017/18	Sep-Nov 17	Feb 18 (*)			

(\*) The present report is **Analytical Report 10** and provides an analysis of the 2017 Full Measures survey for Hartlepool Borough Council's frontage.

In addition, separate reports are produced for other elements of the programme as and when specific components are undertaken, such as wave data collection, bathymetric and sea bed sediment data collection, aerial photography, and walk-over visual inspections. For purposes of analysis, the Cell 1 frontage has been split into the sections listed in Table 2.

**Table 2 Sub-divisions of the Cell 1 Coastline**

Authority	Zone
Northumberland County Council	Spittal A
	Spittal B
	Goswick Sands
	Holy Island
	Bamburgh
	Beadnell Village
	Beadnell Bay
	Embelton Bay
	Boulmer
	Alnmouth Bay
	High Hauxley and Druridge Bay
	Lynemouth Bay
	Newbiggin Bay
	Cambois Bay
Blyth South Beach	
North Tyneside Council	Whitley Sands
	Cullercoats Bay
	Tynemouth Long Sands
	King Edward's Bay
South Tyneside Council	Litehaven Beach
	Herd Sands
	Trow Quarry (incl. Frenchman's Bay)
	Marsden Bay
Sunderland Council	Whitburn Bay
	Harbour and Docks
	Hendon to Ryhope (incl. Halliwell Banks)
Durham County Council	Featherbed Rocks
	Seaham
	Blast Beach
	Hawthorn Hive
	Blackhall Colliery
Hartlepool Borough Council	North Sands
	Middleton
	Hartlepool Bay
	North Gare
Redcar & Cleveland Borough Council	Coatham Sands
	Redcar Sands
	Marske Sands
	Saltburn Sands
	Cattersty Sands (Skinningrove)
Scarborough Borough Council	Staithes
	Runswick Bay
	Sandsend Beach, Upgang Beach and Whitby Sands
	Robin Hood's Bay
	Scarborough North Bay
	Scarborough South Bay
	Cayton Bay
Filey Bay	



## 1. Introduction

### 1.1 Study Area

Hartlepool Borough Council's frontage extends from Crimdon Beck in the north, to the North Gare Breakwater in the south. For the purposes of this report, it has been sub-divided into four areas, namely:

- North Sands
- Hartlepool Headland
- Middleton
- Hartlepool Bay

### 1.2 Methodology

Along Hartlepool Borough Council's frontage, the following surveying is undertaken:

- Full Measures survey annually each autumn/early winter comprising:
  - Beach profile surveys along twelve transect lines
  - Topographic survey along part of North Sands (referred to as Hartlepool North or 'HN')
  - Topographic survey along Middleton (referred to as Hartlepool Central or 'HC')
  - Topographic survey along Hartlepool Bay (referred to as Hartlepool South or 'HS')
- Partial Measures survey annually each spring comprising:
  - Beach profile surveys along twelve transect lines
- Additionally, every five years (starting with 2008 as the baseline year), the Full Measures topographic survey at Hartlepool North is extended to fully cover the whole of North Sands and Hartlepool Headland with a topographic survey. This extends across the boundary of jurisdiction between Hartlepool Borough Council and County Durham Council.

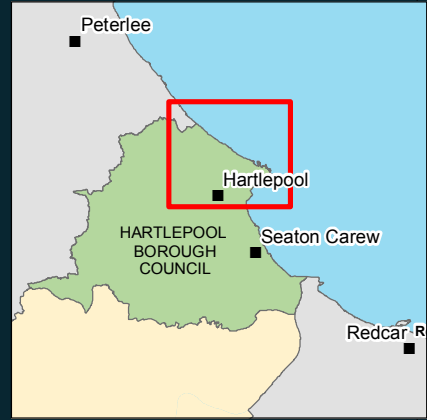
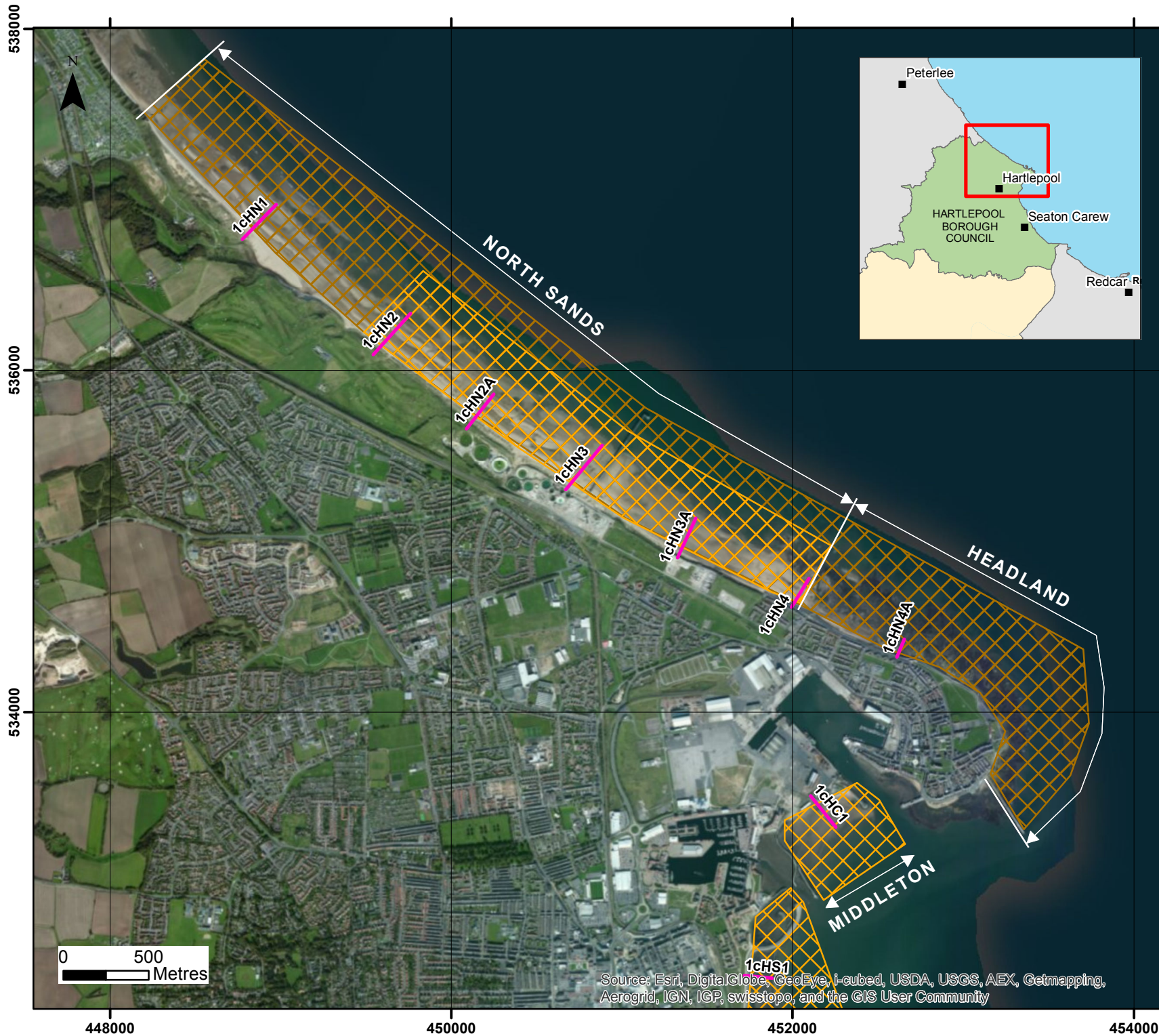
The location of these surveys is shown in Figure 2. The 2017 Full Measures survey was undertaken along this frontage on various dates between 18th September and 23rd November. During this time, the weather was variable. The survey reports from Academy Geomatics document details of the weather conditions over this survey period.

All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data collection approach and file format is comparable to that being used on other regional coastal monitoring programmes, such as in the South East and South West of England.

Upon receipt of the data from the survey team, they are quality assured and then uploaded onto the programme's website for storage and availability to others and also input to SANDS and GIS for subsequent analysis. The Analytical Report is then produced following a standard structure for each authority. This involves:

- description of the changes observed since the previous survey and an interpretation of the drivers of these changes (Section 2);
- documentation of any problems encountered during surveying or uncertainties inherent in the analysis (Section 3);
- recommendations for 'fine-tuning' the programme to enhance its outputs (Section 4); and
- providing key conclusions and highlighting any areas of concern (Section 5).

Data from the present survey are presented in a processed form in the Appendices.



Key

**SURVEY LOCATIONS**

**Topographic Profiles**

- Annual
- Bi-Annual

**Topographic Surveys**

- 6 monthly
- yearly
- 5 yearly

*(Indicative Survey Extents shown)*

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

**Figure 2 - Map 1**  
**Hartlepool Borough Council Frontage**

Analytical Report  
 Topo Surveys

Drawing Scale at A4 1:30,000

**WATER**  
 Royal HaskoningDHV  
 Marlborough House  
 Marlborough Crescent  
 Newcastle upon Tyne  
 NE1 4EE

Tel: +44 (0)191 211 1300  
 Fax: +44 (0)191 211 1313  
[www.royalhaskoningdhv.com](http://www.royalhaskoningdhv.com)



Source: Esri, DigitalGlobe, GeoEye, I-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



Key

**SURVEY LOCATIONS**

**Topographic Profiles**

- Annual (Blue line)
- Bi-Annual (Pink line)

**Topographic Surveys**

- 6 monthly (Green cross-hatch)
- yearly (Orange cross-hatch)
- 5 yearly (Brown cross-hatch)

*(Indicative Survey Extents shown)*

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

**Figure 2 - Map 2**

**Hartlepool Borough Council Frontage**

Analytical Report  
Topo Surveys

Drawing Scale at A4 1:30,000

**WATER**  
 Royal HaskoningDHV  
 Marlborough House  
 Marlborough Crescent  
 Newcastle upon Tyne  
 NE1 4EE

Tel: +44 (0)191 211 1300  
 Fax: +44 (0)191 211 1313  
 www.royalhaskoningdhv.com



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Key

**SURVEY LOCATIONS**

**Topographic Profiles**

- Annual
- Bi-Annual

**Topographic Surveys**

- 6 monthly
- yearly
- 5 yearly

*(Indicative Survey Extents shown)*

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

**Figure 2 - Map 3**  
**Hartlepool Borough**  
**Council Frontage**

Analytical Report  
 Topo Surveys

Drawing Scale at A4 1:12,000

**WATER**  
 Royal HaskoningDHV  
 Marlborough House  
 Marlborough Crescent  
 Newcastle upon Tyne  
 NE1 4EE

Tel: +44 (0)191 211 1300  
 Fax: +44 (0)191 211 1313  
[www.royalhaskoningdhv.com](http://www.royalhaskoningdhv.com)



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## 2. Analysis of Survey Data

### 2.1 North Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
<p style="text-align: center;"><b>17<sup>th</sup> November 2017</b></p>	<p><b>Beach Profiles:</b></p> <p>North Sands is covered by seven beach profile lines during the Full Measures survey (Appendix A). They were last surveyed in April 2017.</p> <p>Profile <b>1cHN1</b> is located within Durham County Council's area of responsibility, about 400m north of the outfall of Crimdon Beck, but is reported here so changes can be interpreted in association with those observed elsewhere along North Sands at HN2, HN3 and HN4.</p> <p>The beginning of profile <b>1cHN1</b> between 0m and 70m change covers dunes and has not changed. The rest of the profile is dominated by accretion of 0.4m, with the toe of the beach showing accretion of up to 0.7m. The berm present on the previous survey between chainage 190m and 260m has been removed, creating a smoother profile. Overall, the profile is at a high level compared to the range recorded in previous surveys, particularly at the toe of the beach.</p> <p>At Profile <b>1cHN2</b>, the profile has not changed on the section with dunes. Between chainage 60m and 140m the beach level has accreted by up to 0.7m. Between 140m and 215m chainage there has been erosion of 0.5m, with the berm crest (previously recorded at chainage 180m) moving seawards by c.40m to chainage 220m. There has been accretion of up to 0.7m on the lower beach from chainage 215m, suggesting drawdown from the mid-beach. Overall the profile is at a medium level compared with the range recorded from previous surveys.</p> <p><b>Profile 1cHN2a</b> was established in October 2011 and runs through the dunes close to North Sands. There has been little change compared to the April 2017 survey up to chainage 95m. From chainage 95m there has been accretion of up to 0.6m, except for the toe of the beach which has steepened through erosion of up to 0.4m.. Overall the profile is smoother compared to the April 2017 survey and is at a medium-high level compared with the range recorded from previous surveys, with the lower beach between chainage 245m and 290m having the highest recorded levels.</p> <p>At Profile <b>1cHN3</b> there has been little change of the dunes. The majority of the beach profile shows</p>	<p>The profiles are all dominated by accretion. Profiles 1cHN2a and 1cHN3 in the centre of the bay do show some erosion at the toe of the beach. The beach levels are now at a medium level across most of the bay compared to the range from previous surveys.</p> <p><b>Longer term trends:</b> The 2017 full measures survey is not entirely in line with the longer term trends which suggest accretion in the west, stability in the middle of the bay and erosion in the east.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>accretion of up to 0.6m. However seaward of chainage 255m the toe of the beach has eroded by up to 0.6m, moving the toe of the beach landwards by c.25m. Overall, the profile is at a medium-low level compared to the range recorded from previous surveys.</p> <p>At Profile <b>1cHN3a</b> there has been stability down to the dune face at 25m chainage. The majority of the profile shows accretion of up to 0.6m. There has been the formation of a lower beach berm at chainage 220m.. Overall, the profile is at a medium level compared to the range recorded from previous surveys,, with the exception of the seaward end (chainage 200m onwards) which is relatively high.</p> <p>At Profile <b>1cHN4</b> there has been very little change to chainage 60m. Between chainage 60m and 140m there has been an accumulation of sand across the previously exposed rock platform of up to 0.6m. From 140m to the end of the survey the rocks on the bottom of the beach are exposed, which is usual for this profile. Overall the profile is at a low-medium level compared to the range recorded from previous surveys..</p> <p>At Profile <b>1cHN4a</b> there has been a large accumulation of sand of up to 1.0m across the upper beach between chainage 10m and 45m covering the previously exposed rock platform. This is a similar pattern to that recorded in 2016. Seawards of 45m chainage the rock platform is exposed and shows little change to previous surveys, with the exception of an accumulation of 0.4m of sand between 55m and 70m chainage Overall the profile is at a medium-high level compared to the range recorded from the previous survey.</p> <p><b>Topographic Survey:</b></p> <p>North Sands is covered by an annual topographic survey. Data from the 2017 Full Measures survey have been used to create a DGM (Appendix B – Map 1) using a GIS package. The majority of the frontage is characterised by shore-parallel contours, except in the vicinity of outfalls, groynes and the pier where contours change direction.</p> <p>The GIS has also been used to calculate the differences between the Autumn 2016 and Autumn 2017 topographic surveys, as shown in Appendix B – Map 4, to identify areas of net erosion and accretion. The changes are generally patchy though roughly shore parallel, with roughly equal areas of erosion and accretion. There is a consistent narrow band of erosion at the top of the beach. The magnitude of change is greater to the west of the central pier than the east.</p>	

<b>Survey Date</b>	<b>Description of Changes Since Last Survey</b>	<b>Interpretation</b>

## 2.2 Middleton

Survey Date	Description of Changes Since Last Survey	Interpretation
<p style="text-align: center;"><b>18<sup>th</sup> September 2017</b></p>	<p><b>Beach Profiles:</b></p> <p>Middleton is covered by one beach profile line during the Full Measures survey (Appendix A). The beach at Profile <b>1cHC1</b> between the seawall at 50m chainage and 155m chainage shows accretion of up to 0.6m, but more typically &lt;0.2m. Seawards of 155m there has been erosion of 0.2m, steepening the toe. Overall the beach is at a medium-high level compared to the range from previous surveys.</p>	<p>The beach profile showed a gain in the upper beach and a loss in the lower beach and steepening overall. The difference plot for Middleton shows erosion in the east and accretion in the west. In front of the headland the difference plots show a patchy distribution of change due to the thin but mobile cover of sand here.</p>
	<p><b>Topographic Survey:</b></p> <p>The frontage is covered by an annual topographic survey between Middleton Jetty and North Pier. Data from the 2017 Full Measures survey have been used to create a DGM (Appendix B – Map 1) using GIS software. Beach contours indicate a steeper beach in the east than the west, with the contours locally affected by pipelines and groynes. In the Autumn 2013 survey, differences between the eastern and western ends of the beach were less marked. Earlier years show a similar topography to 2014 and 2015.</p> <p>The GIS has also been used to calculate the differences between the Autumn 2016 and Autumn 2017 topographic surveys, as shown in Appendix B – Map 5, to identify areas of net erosion and accretion. The beach near the Headland shows a patchy distribution of accretion and erosion, with there generally being little change or erosion in the east and accretion in the west. At Middleton erosion dominates in the east, with erosion in the east and in a narrow band at the top of the beach along the whole beach. The changes observed at Middleton beach over the year are modest at less than <math>\pm 0.75\text{m}</math>.</p>	<p><b>Longer term trends:</b></p> <p>The beach is in the mid-range of the previously recorded levels but is relatively steep.</p>



## 2.3 Hartlepool Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
<p style="text-align: center;"><b>22<sup>nd</sup> November 2017</b></p>	<p><b>Beach Profiles:</b></p> <p>Hartlepool Bay is covered by four beach profile lines during the Full Measures survey (Appendix A). The profiles were last surveyed in April 2017. Sea coalers had been banned from driving onto the beach in 2013 but on 28<sup>th</sup> March 2015 the gates were opened and they were allowed to remove coal from the beach again (Hartlepool Mail).</p> <p>Profile <b>1cHS1</b> is located approximately 150m south of the root of the South Pier. The profile starts at the wall to the rear of the promenade and extends across the promenade, over the fronting concrete splash wall and down the sloping face of the rock armour revetment before reaching the beach. There has been erosion of up to 0.3m at the toe of the rock armour revetment. Between chainage 45m and 85m there has been accretion of up to 0.2m. The toe of the beach has been eroded by 0.4m, moving landwards by c.25m. The beach level is at a medium-high level along the entire profile compared to the range recorded from previous surveys.</p> <p>There has been accretion of up to 0.3m along all but the most seaward end of Profile <b>1cHS2</b>. Seaward of chainage 230m the beach has lowered by up to 0.3m, moving the toe of the landwards by c.40m. The overall effect has been to steepen the beach. Overall, the profile is at a high-medium level compared to the range recorded from previous surveys.</p> <p>At profile <b>1cHS3</b> there has been accretion of up to 0.4m across the majority of the profile. The lower foreshore seaward of 240m has however eroded by up to 0.4m, steepening the toe of the beach and moving it landwards by c.20m. Overall, the profile is at a high-medium level compared to the range recorded from previous surveys.</p> <p>The profile <b>1cHS4</b> is located further south, around 1km north of the North Gare breakwater in an area of undefended dunes at Seaton Sands. The profile covers approximately 325m of dunes before the beach. The dune section is stable, with a foredune continuing to accrete at around 320m chainage with 0.2m of growth since April 2017. An upper beach berm has formed at m, through the accretion of 0.8m of sand. Between chainage 380m and 500m there has been very little change in beach levels, limited to ±0.1m. Between chainage 500m and 550m there has been accretion of up to 0.4m. The toe of the</p>	<p>The profiles have shown stability over 2017, being dominated by accretion except for the toe of the beach which shows erosion in all profiles.</p> <p><b>Longer term trends:</b> Profiles 1cHS1-1cHS3 have all shown progressive accretion since the beginning of the surveys. The beach levels are relatively high. The high beaches may be due to the northward transport of sediment from the dunes. The foredune at profile 1cHS4 continues to develop although footfall may be damaging it and leading to erosion.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>beach from chainage 550m shows erosion of 0.2m and has steepened. Overall, the profile is at a medium level compared to the range recorded from previous surveys.</p>	
	<p><b>Topographic Survey:</b></p> <p>Hartlepool Bay is covered by an annual topographic survey between the South Pier and the North Gare Breakwater. Data from the 2017 Full Measures survey have been used to create a DGM (Appendix B – Map 2) using a GIS software package. The plot shows the two smaller bays within the larger Hartlepool Bay frontage. These smaller bays are separated by a slight promontory at Carr House Sands between Hartlepool and Seaton Carew. The beach contours are generally shore parallel, except where linear features (e.g. outfalls) and rock outcrops are present, such as in the northern part of Seaton Sands. Elevations at the rear of the beach are lowest in the north of the survey area near South Pier and higher further south.</p> <p>The GIS has also been used to calculate the differences between the Autumn 2016 and Autumn 2017 topographic surveys, as shown in Appendix B – Map 5, to identify areas of erosion and accretion. The changes recorded over 2017 show the northern bay has undergone little change with the changes observed at less than <math>\pm 0.75\text{m}</math>. Where change has happened, it is predominantly erosion. In the southern bay the scale of change is greater, and increases in magnitude towards the southern end of the bay with over <math>\pm 1\text{m}</math> change. The southern bay is dominated by shore parallel bands of erosion with some areas of accretion in the lower foreshore.</p>	<p>It should be noted that the topographic survey represents the changes over a year from the Full Measures 2016 survey, and the profiles record the changes since the April 2017 Partial Measures survey. Therefore, the patterns observed do not necessarily match up.</p>

## 2.4 North Gare

Survey Date	Description of Changes Since Last Survey	Interpretation
<p style="text-align: center;"><b>23<sup>rd</sup> November 2017</b></p>	<p><b>Topographic Survey:</b></p> <p>North Gare is covered by an annual topographic survey between the North Gare Breakwater and the Seaton on Tees Channel. The area is designated as the Teesmouth National Nature Reserve. Surveys have been carried out since Autumn 2011.</p> <p>Data from the 2016 Full Measures survey have been used to create a DGM (Appendix B – Map 3) using GIS software. The beach contours recorded in 2017 show the promontory and the contours run shore parallel to the beach in the north. In the south of the study area the contours diverge from the shore line and there is an extensive flat area between the shoreline and MHW. However, the lower beach and foreshore are much steeper in the south of the survey area than in the north.</p> <p>The GIS has also been used to calculate the differences between the Autumn 2016 and Autumn 2017 topographic surveys, as shown in Appendix B – Map 6, to identify areas of net erosion and accretion. The difference plot shows that there are alternating shore parallel bands of accretion and erosion in the north, with accretion dominating the upper and mid beach. The erosion tends to be in the mid and lower beach, with some erosion in the upper beach at the northern end. In the southern part of the survey area, to the north and landward of the promontory there is little change. Seaward of the promontory the pattern is also patchy with accretion dominating, especially in the lower foreshore. However there are some small areas of erosion in a band running north-east along the gravel bank from the end of the promontory. Overall there are more areas of accretion across the survey area; however the biggest magnitude of change is the area of erosion at the northern end of the survey.</p>	<p>The changes seen in the 2017 Full Measures survey is the continuation of the trends seen in the previous survey, with the movement of sand bars across the shore face in the north of the survey area, and accretion on the seaward side of the promontory.</p>

### **3. Problems Encountered and Uncertainty in Analysis**

Beach profile HN1 is located within Durham County Council's area of responsibility but has been reported here so changes can be interpreted in association with those observed elsewhere along North Sands, along HN2, HN3 and HN4.

At Hartlepool North work was still ongoing between profiles 1cHN4 and 1cHN4A on the seawall.

At Middleton there was no access to the upper section of profile 1cHC1.

At North Gare the area south of breakwater was difficult to survey due to very soft sand. Typical ground levels in the saltmarsh area at the south east corner were taken on foot to avoid disturbing the wildlife.

### **4. Recommendations for 'Fine-tuning' the Monitoring Programme**

No further 'fine-tuning' is recommended at the present time.

### **5. Conclusions and Areas of Concern**

- At North Sands, the beach profiles show consistent accretion with some erosion at the toe of the beach in the centre of the bay. The beach is now at a medium level across most of the bay.
- At Middleton, the centre of the bay has accreted over 2016. The continuing erosion of the beach is expected because there are no sources of sediment to the Middleton frontage. The beach in front of the headland had a patchy distribution of change in 2017.
- The majority of changes through 2017 in Hartlepool Bay were modest. Profiles 1cHS1-3 show progressive accretion, which is also supported by the topographic survey difference plot.
- The topographic plots show a continuation of the elevation changes observed since 2013 at North Gare. Throughout 2017 there was modest accretion overall.
- There is no cause for concern at any of these areas.

## **Appendices**

**Appendix A**  
**Beach Profiles**

# Beach Profile

Location: 1cHN1

Date: 17/11/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

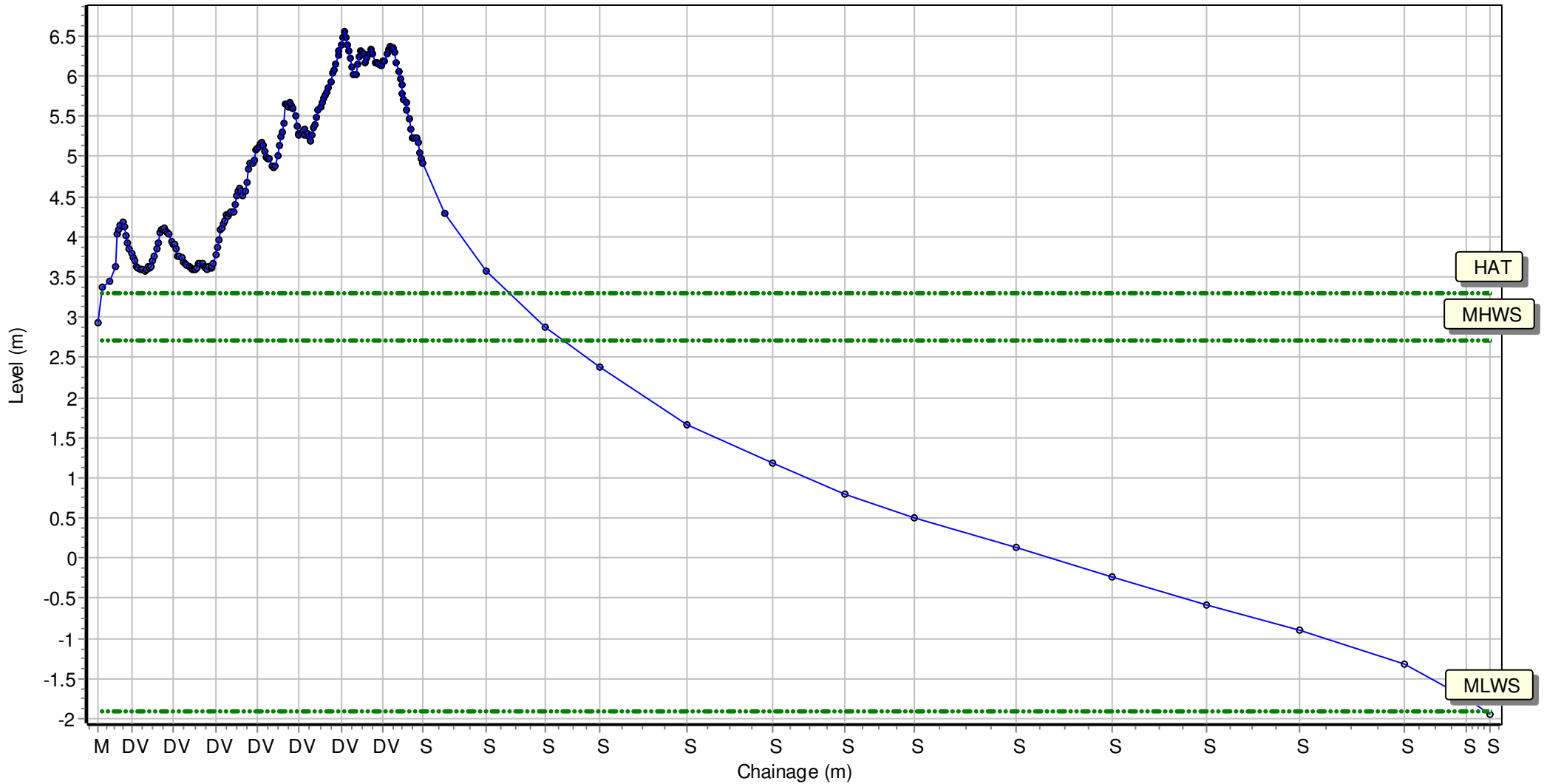
Sea State:

Visibility:

Rain:

Summary: 2017 Full Measures Topo Survey

Easting: 448779.624 Northing: 536767.42 Profile Bearing: 44 ° from North



# Beach Profile

Location: 1cHN2

Date: 17/11/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

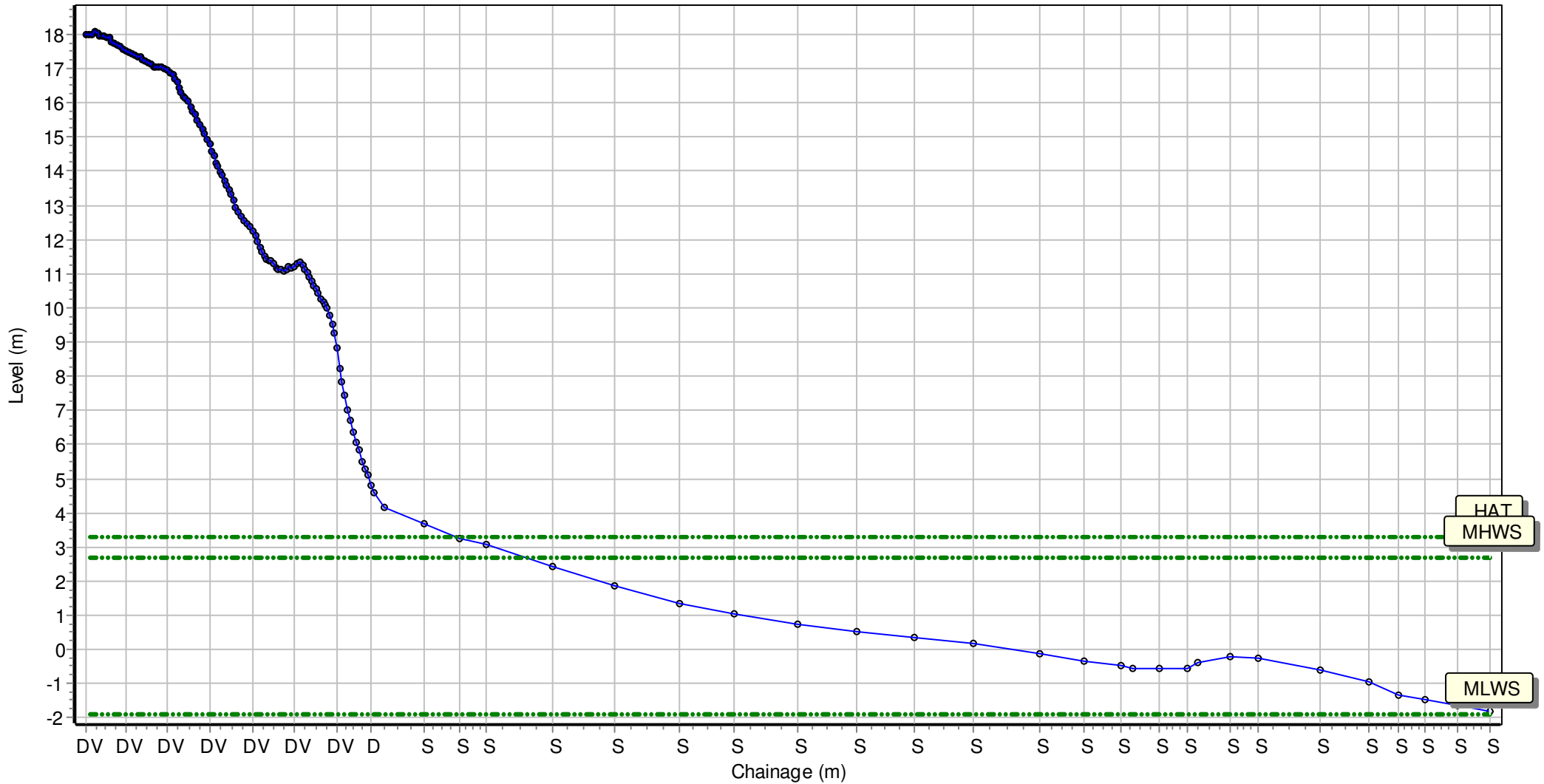
Sea State:

Visibility:

Rain:

Summary: 2017 Full Measures Topo Survey

Easting: 449547.217 Northing: 536095.458 Profile Bearing: 42 ° from North





# Beach Profile

Location: 1cHN2A

Date: 17/11/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

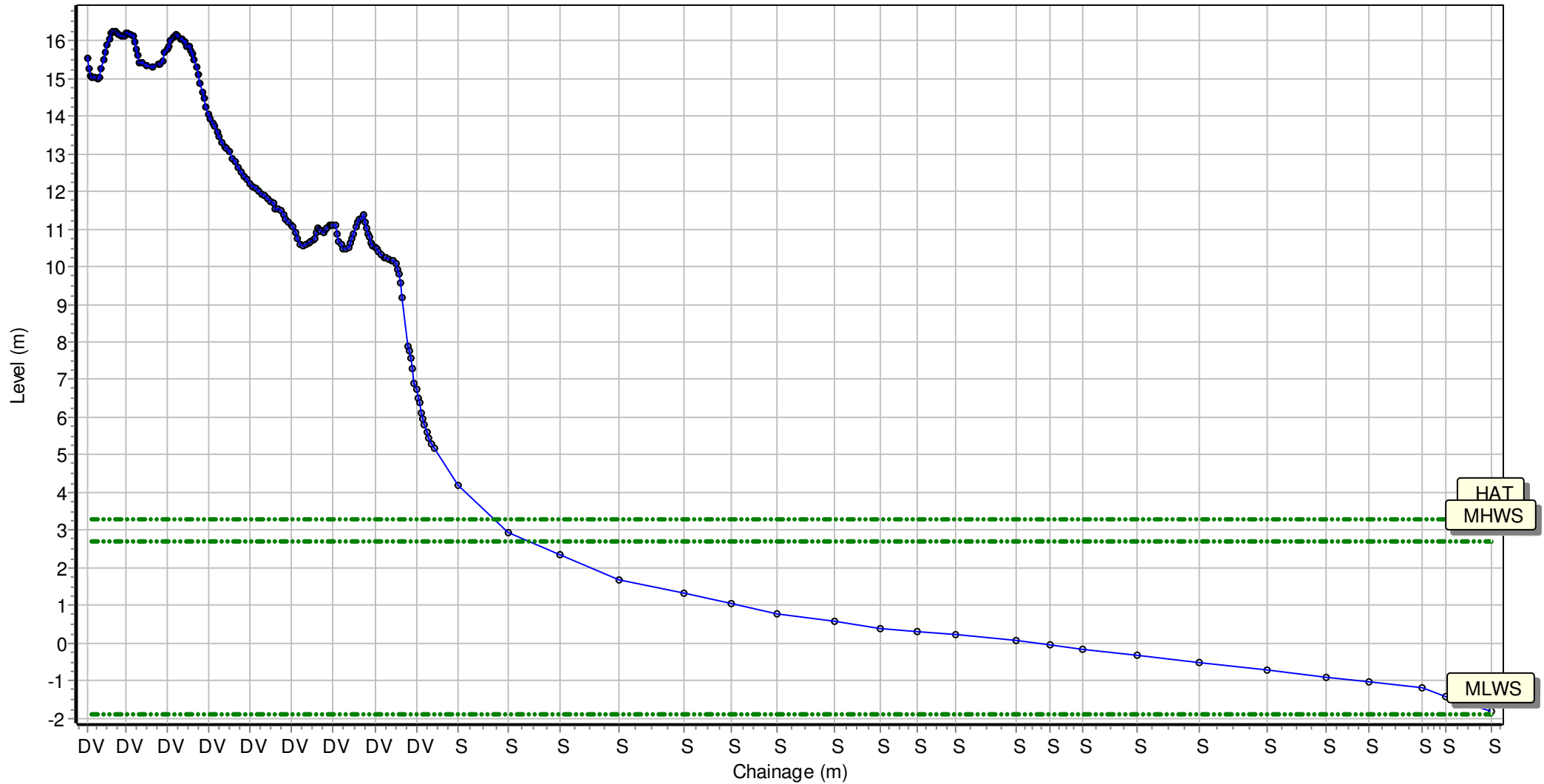
Sea State:

Visibility:

Rain:

Summary: 2017 Full Measures Topo Survey

Easting: 450088.047 Northing: 535658.212 Profile Bearing: 39 ° from North



# Beach Profile

Location: 1cHN3

Date: 17/11/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

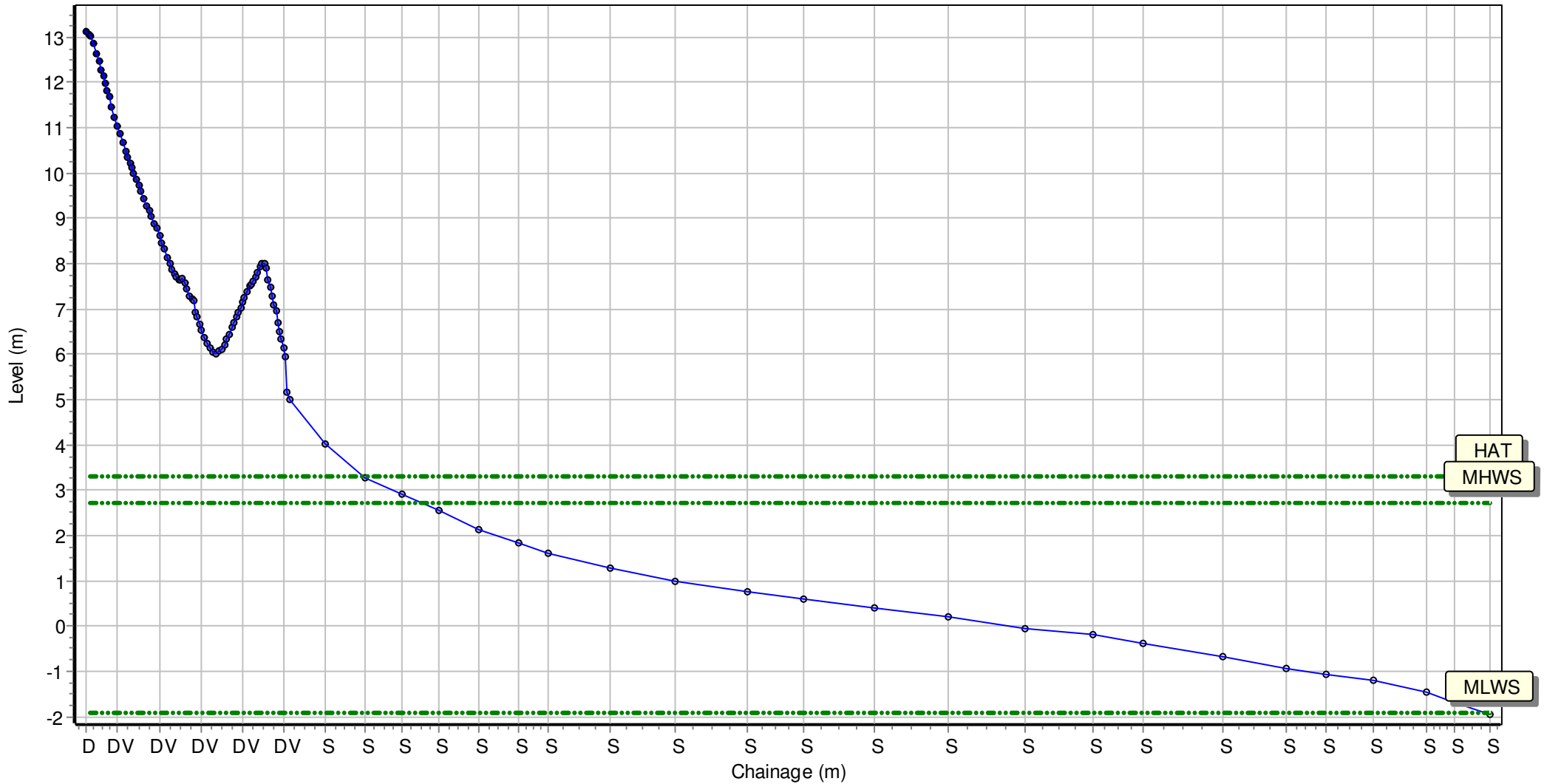
Sea State:

Visibility:

Rain:

Summary: 2017 Full Measures Topo Survey

Easting: 450674.424 Northing: 535305.141 Profile Bearing: 30 ° from North



# Beach Profile

Location: 1cHN3A

Date: 17/11/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

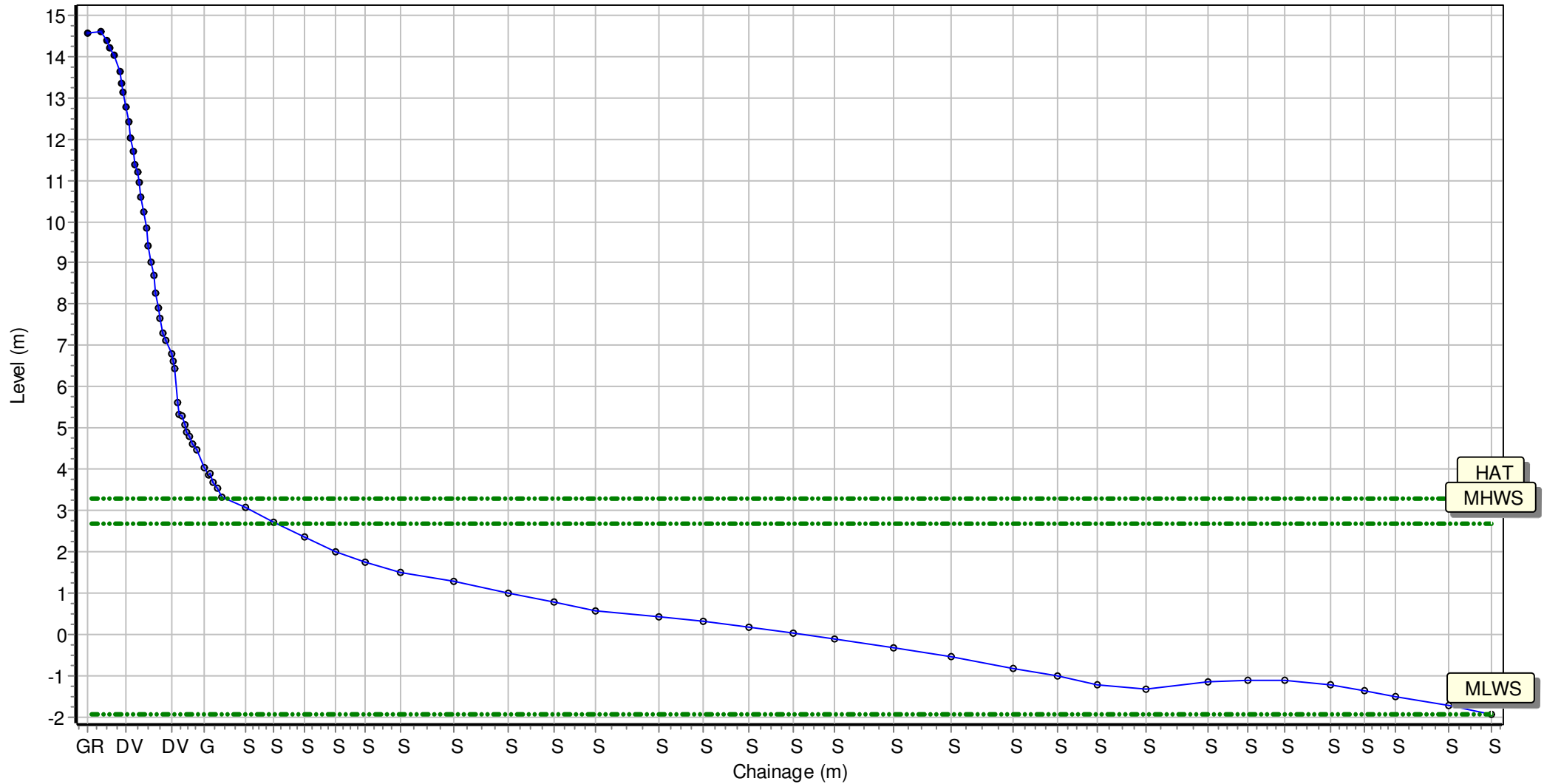
Sea State:

Visibility:

Rain:

Summary: 2017 Full Measures Topo Survey

Easting: 451324.71 Northing: 534903.35 Profile Bearing: 25 ° from North



# Beach Profile

Location: 1cHN4

Date: 17/11/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

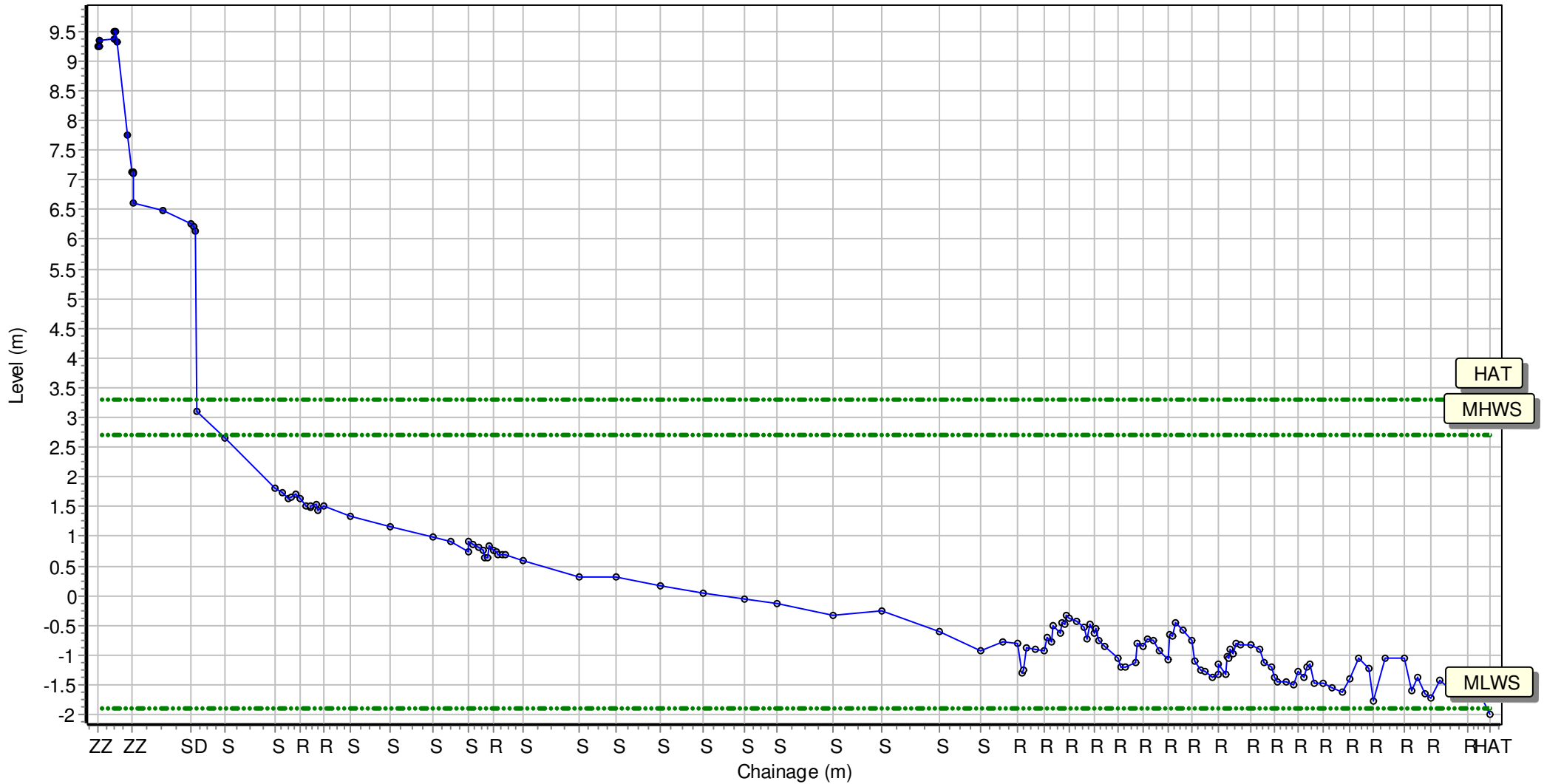
Sea State:

Visibility:

Rain:

Summary: 2017 Full Measures Topo Survey

Easting: 451997.114 Northing: 534616.627 Profile Bearing: 25 ° from North



# Beach Profile

Location: 1cHN4A

Date: 17/11/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

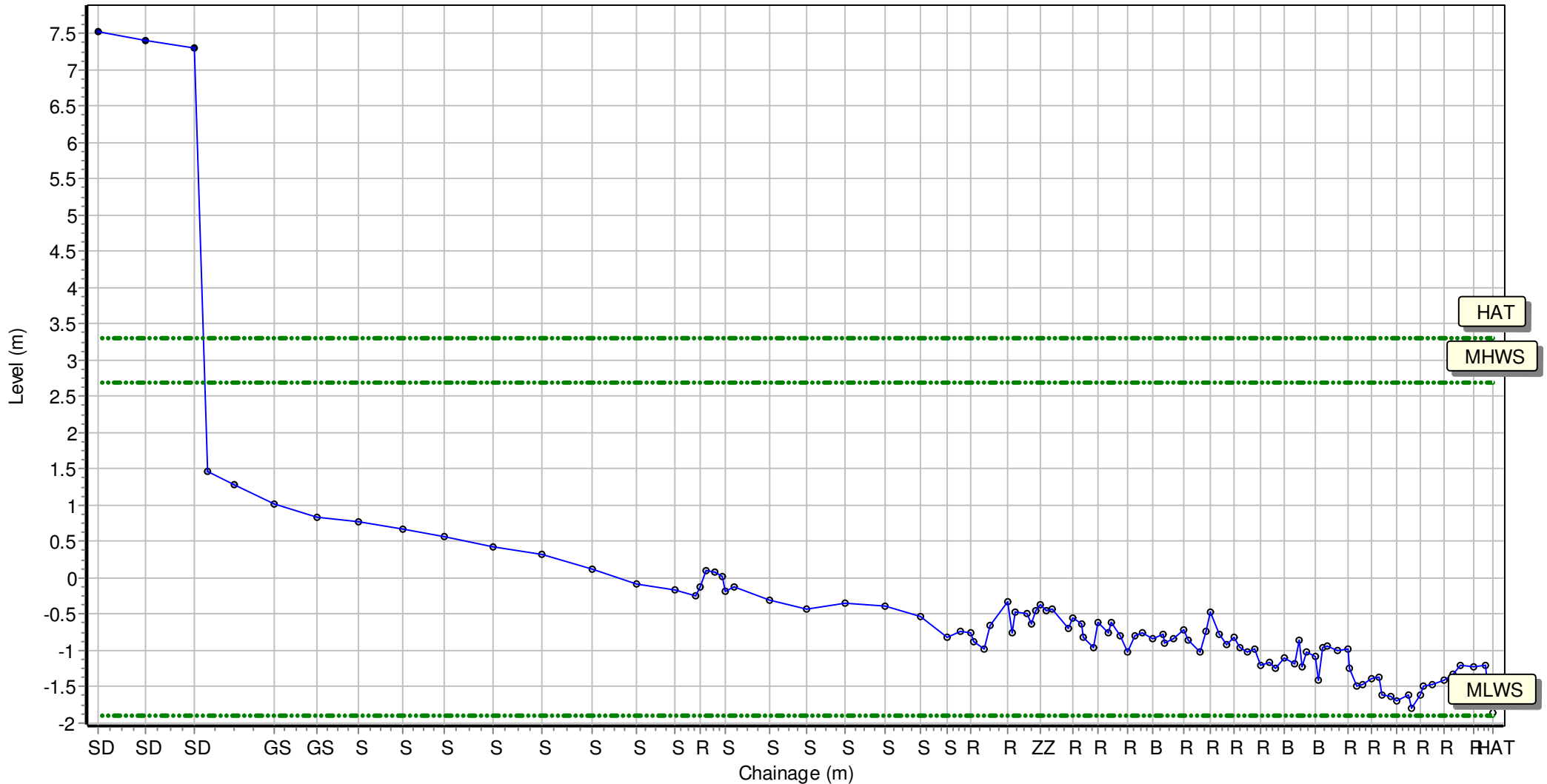
Sea State:

Visibility:

Rain:

Summary: 2017 Full Measures Topo Survey

Easting: 452610.565 Northing: 534321.038 Profile Bearing: 23 ° from North



# Beach Profile

Location: 1cHC1

Date: 18/09/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

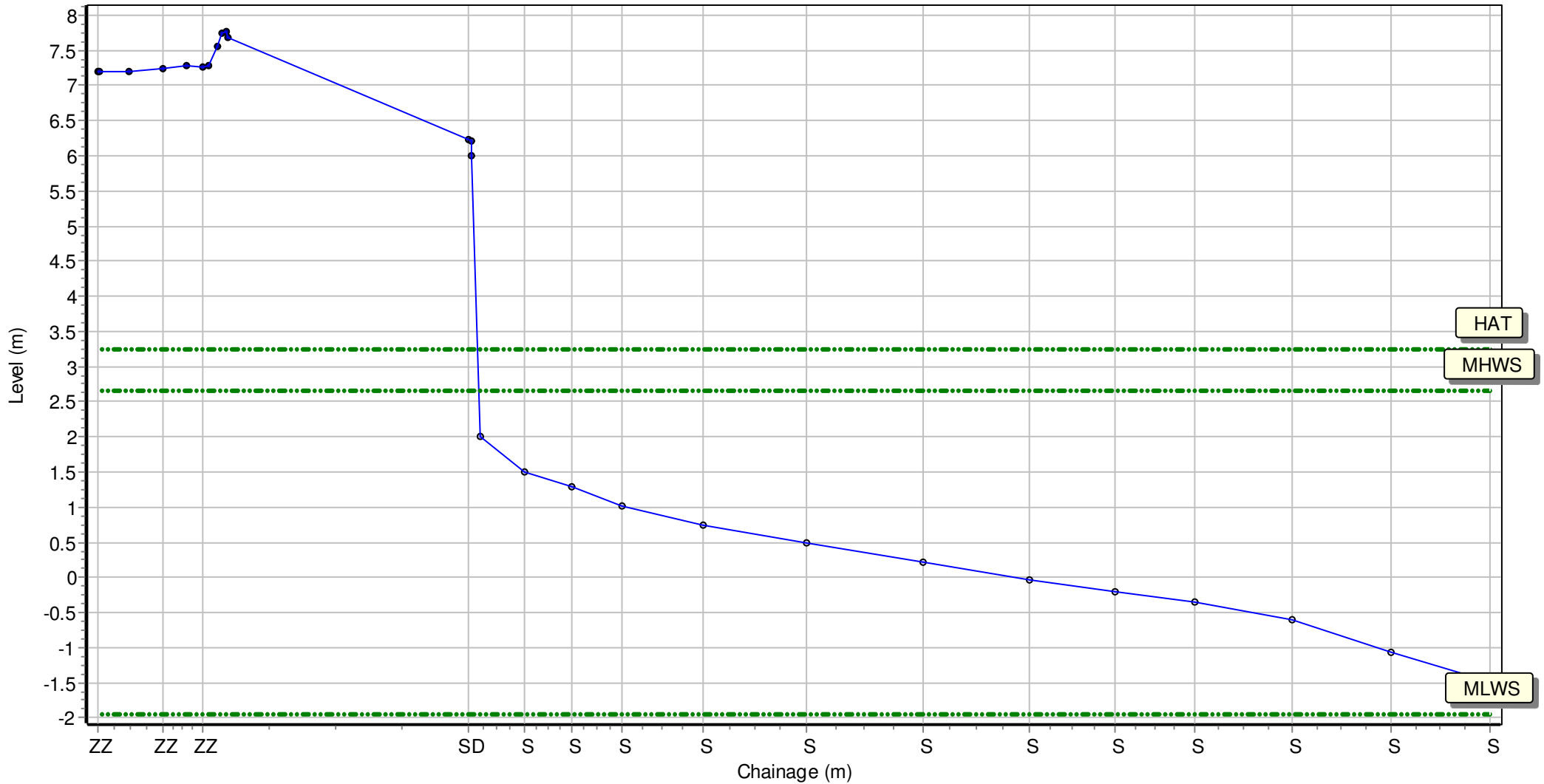
Sea State:

Visibility:

Rain:

Summary: 2017 Full Measures Topo Survey

Easting: 452108.075 Northing: 533506.119 Profile Bearing: 150 ° from North



# Beach Profile

Location: 1cHS1

Date: 22/11/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

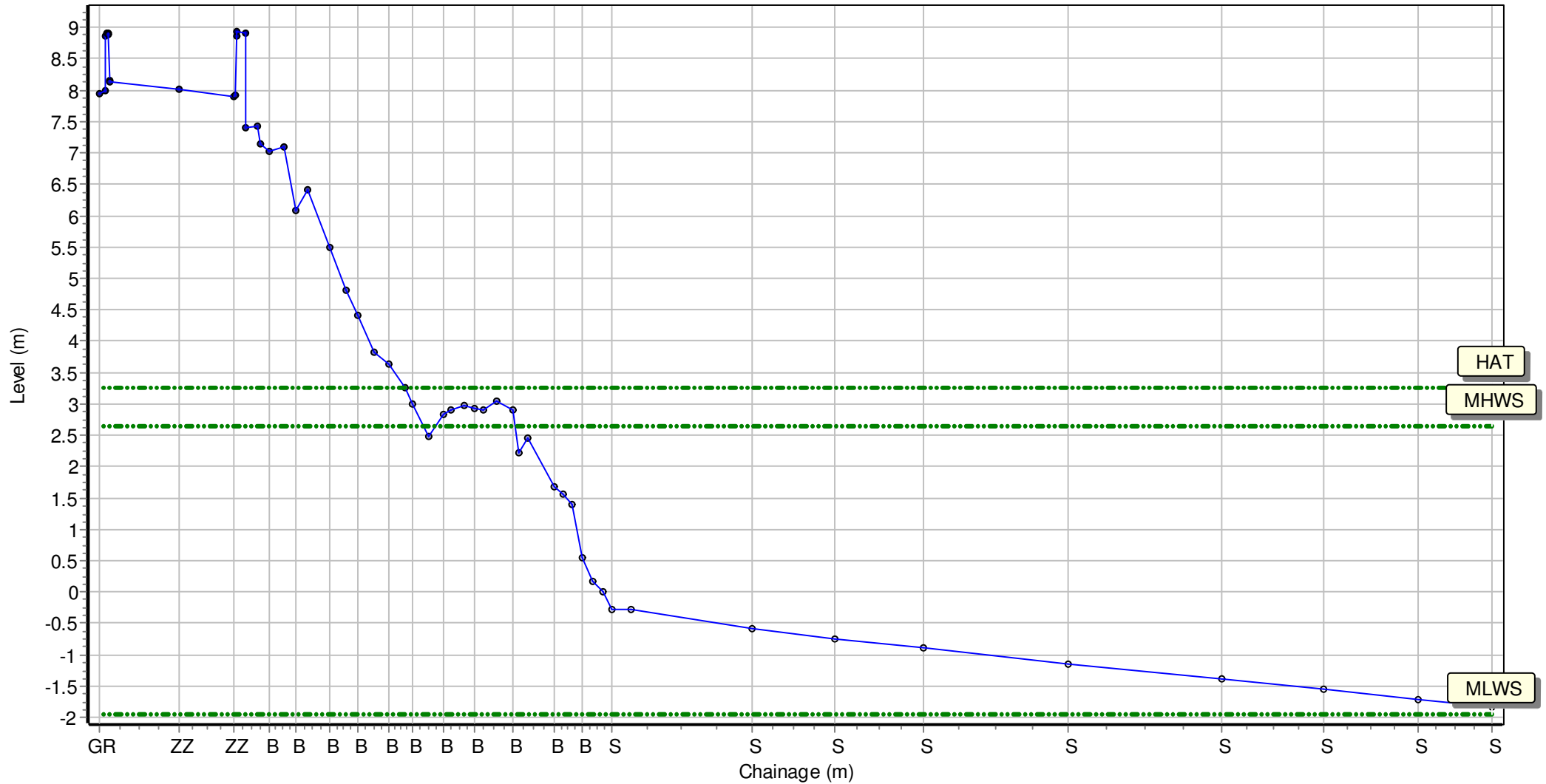
Sea State:

Visibility:

Rain:

Summary: 2017 Full Measures Topo Survey

Easting: 451718 Northing: 532455 Profile Bearing: 95 ° from North



# Beach Profile

Location: 1cHS2

Date: 22/11/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

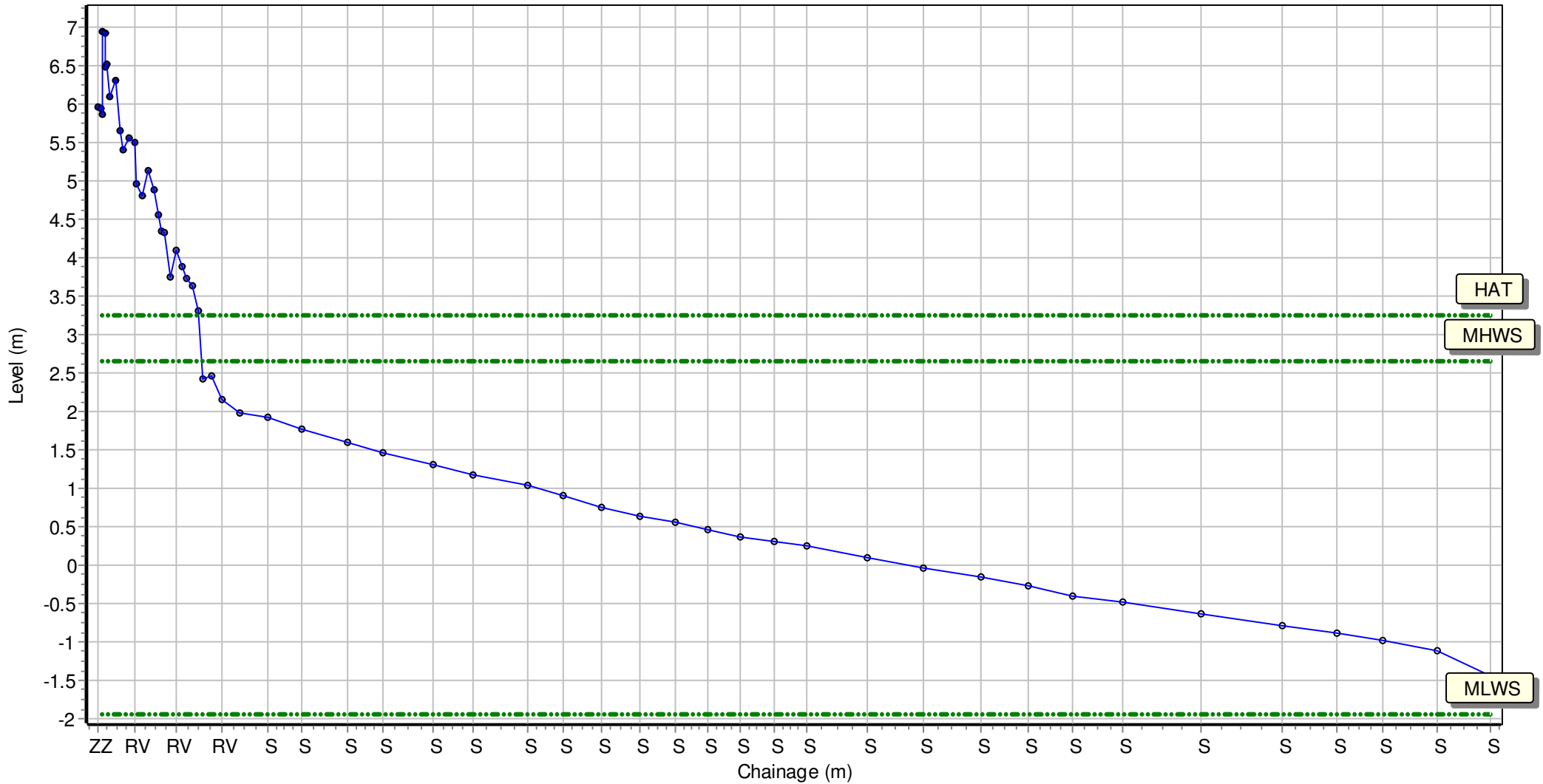
Sea State:

Visibility:

Rain:

Summary: 2017 Full Measures Topo Survey

Easting: 452160.59 Northing: 531071.39 Profile Bearing: 77 ° from North





# Beach Profile

Location: 1cHS3

Date: 22/11/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

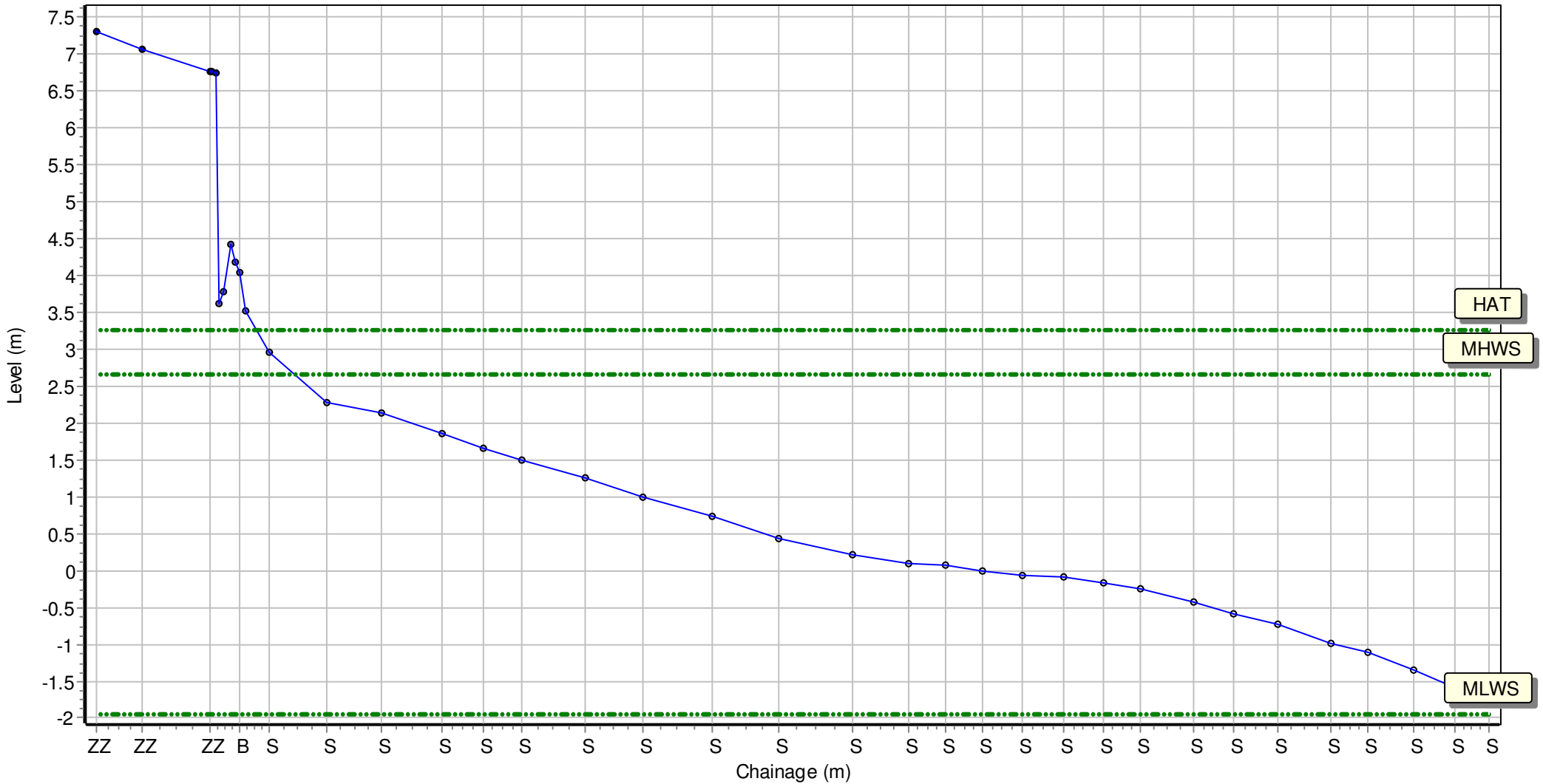
Sea State:

Visibility:

Rain:

Summary: 2017 Full Measures Topo Survey

Easting: 452517.25 Northing: 530064.57 Profile Bearing: 76 ° from North



# Beach Profile

Location: 1cHS4

Date: 22/11/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

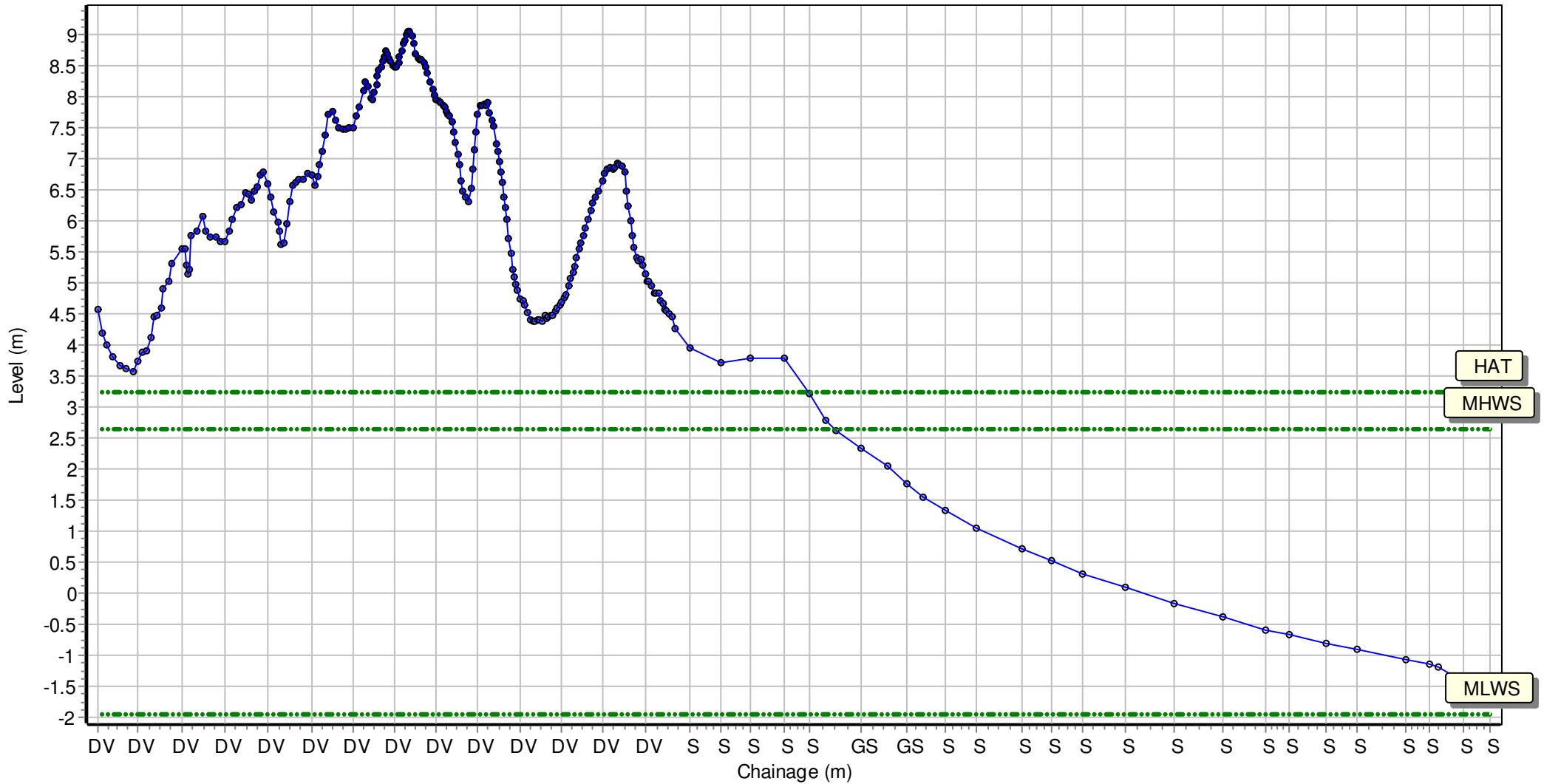
Sea State:

Visibility:

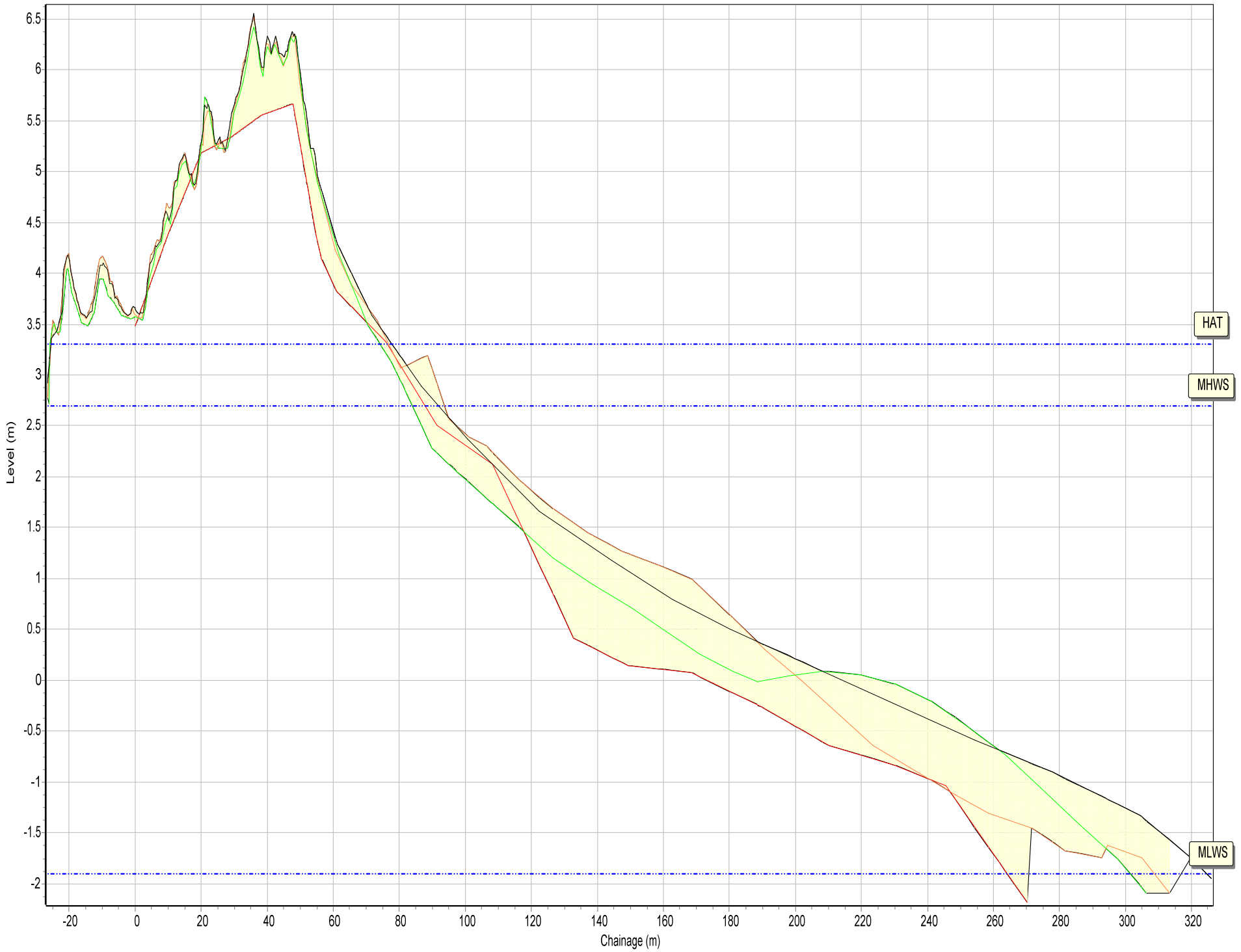
Rain:

Summary: 2017 Full Measures Topo Survey

Easting: 452889 Northing: 528971 Profile Bearing: 76 ° from North



Beach Profiles: 1cHN1



Profiles Envelope  
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31/08/2016  
01/04/2017  
17/11/2017

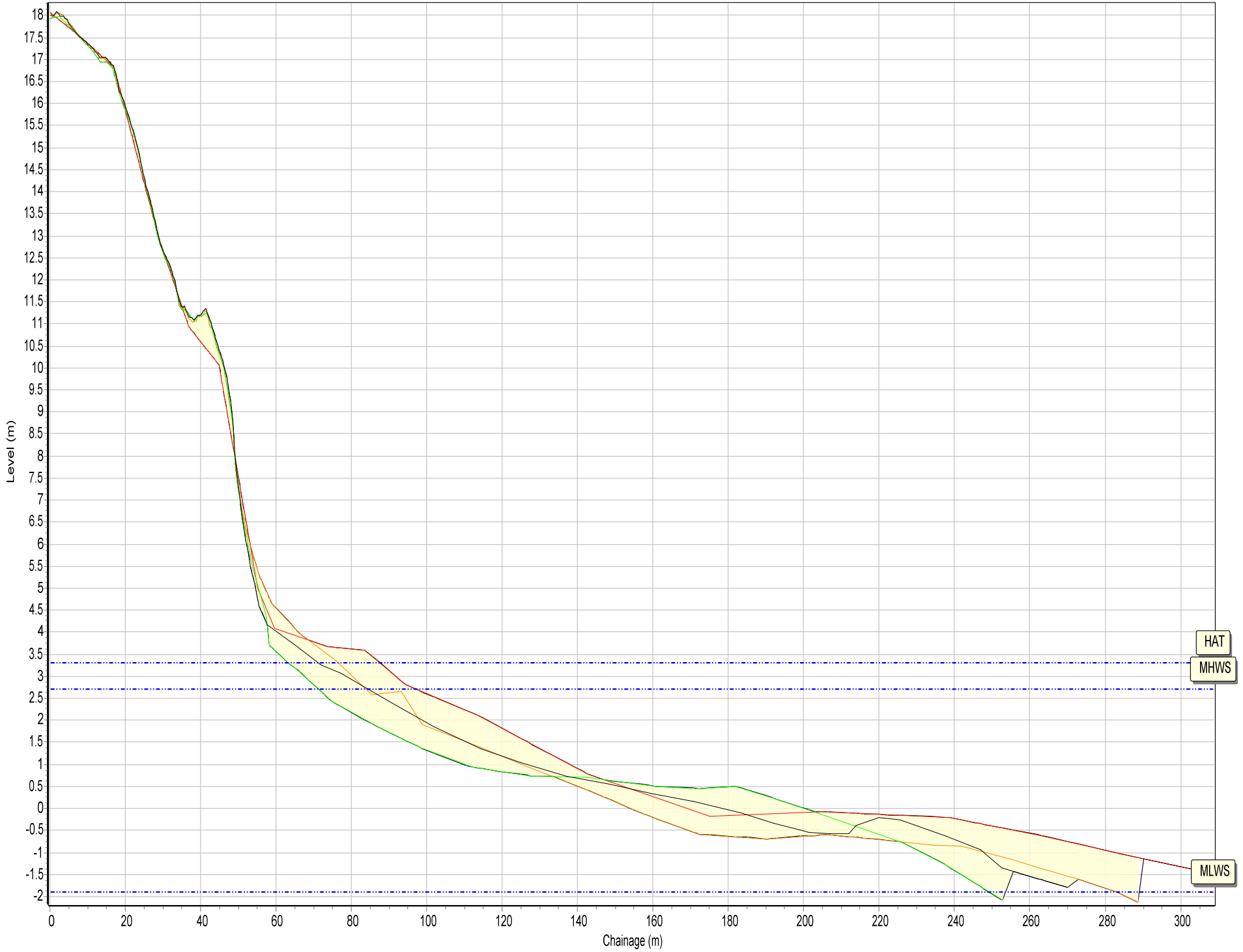
HAT

MHWS

MLWS

SANDS

Beach Profiles: 1cHN2



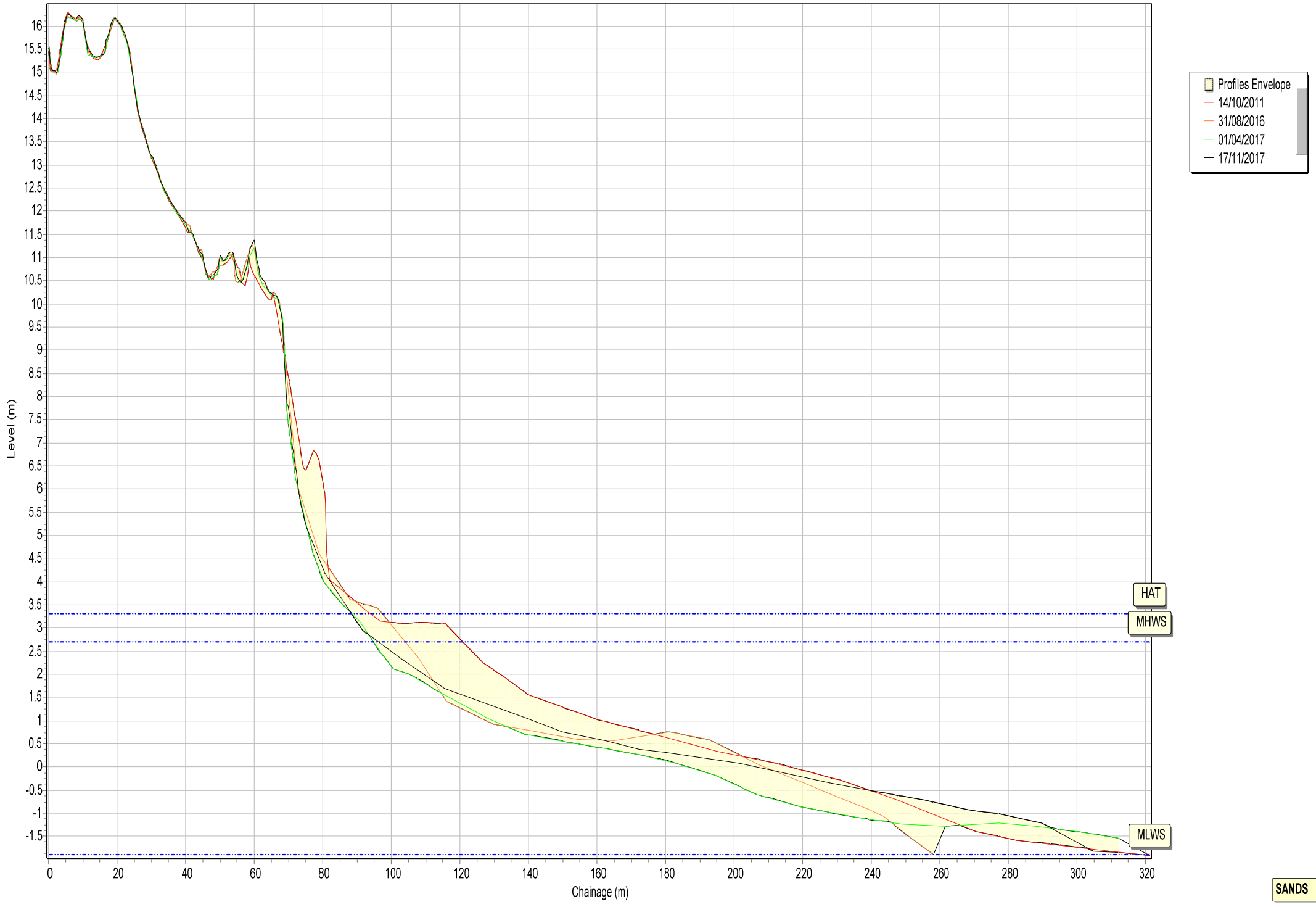
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17/11/2017

HAT  
MHWS

MLWS

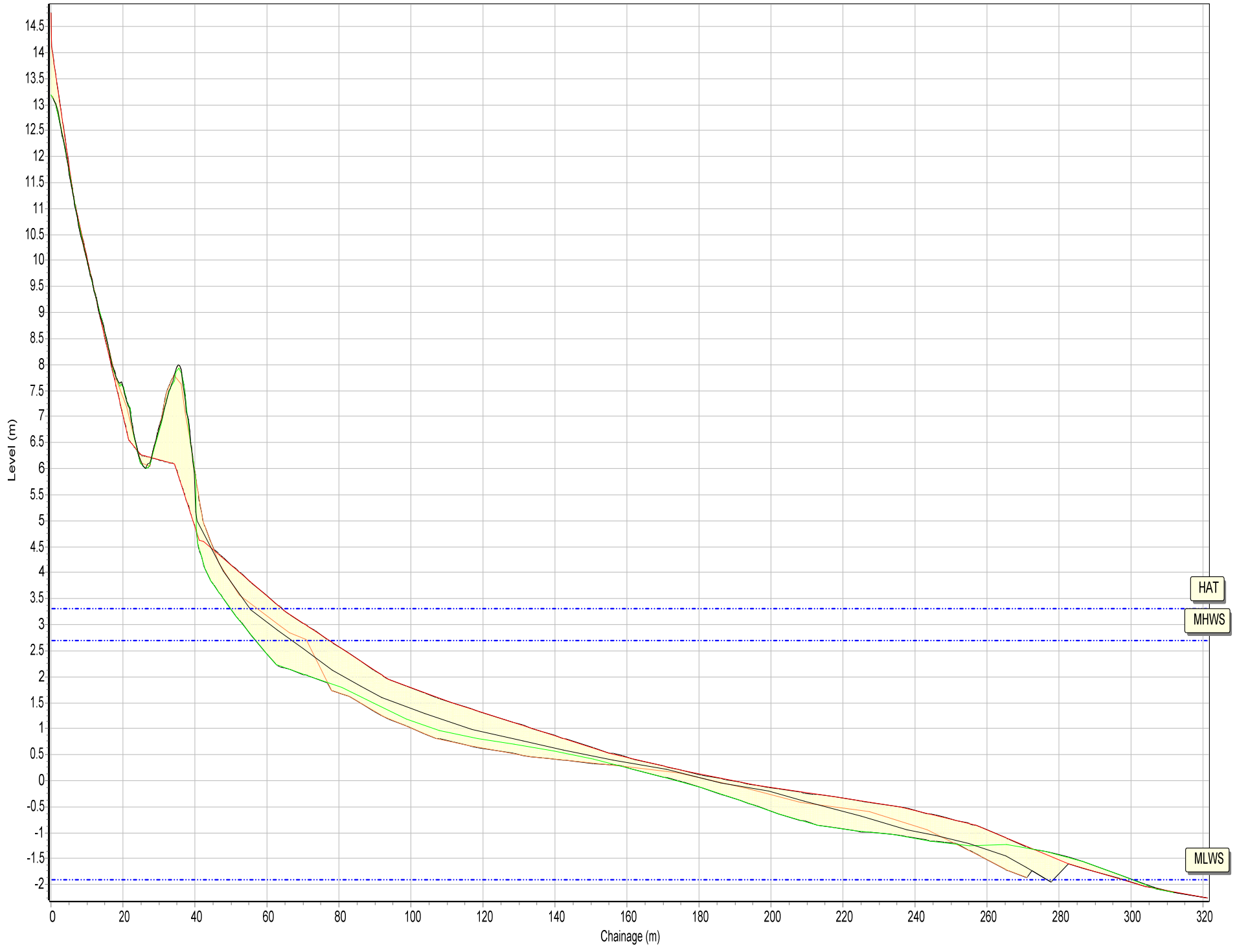
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Beach Profiles: 1cHN2A



SANDS

Beach Profiles: 1cHN3



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17/11/2017

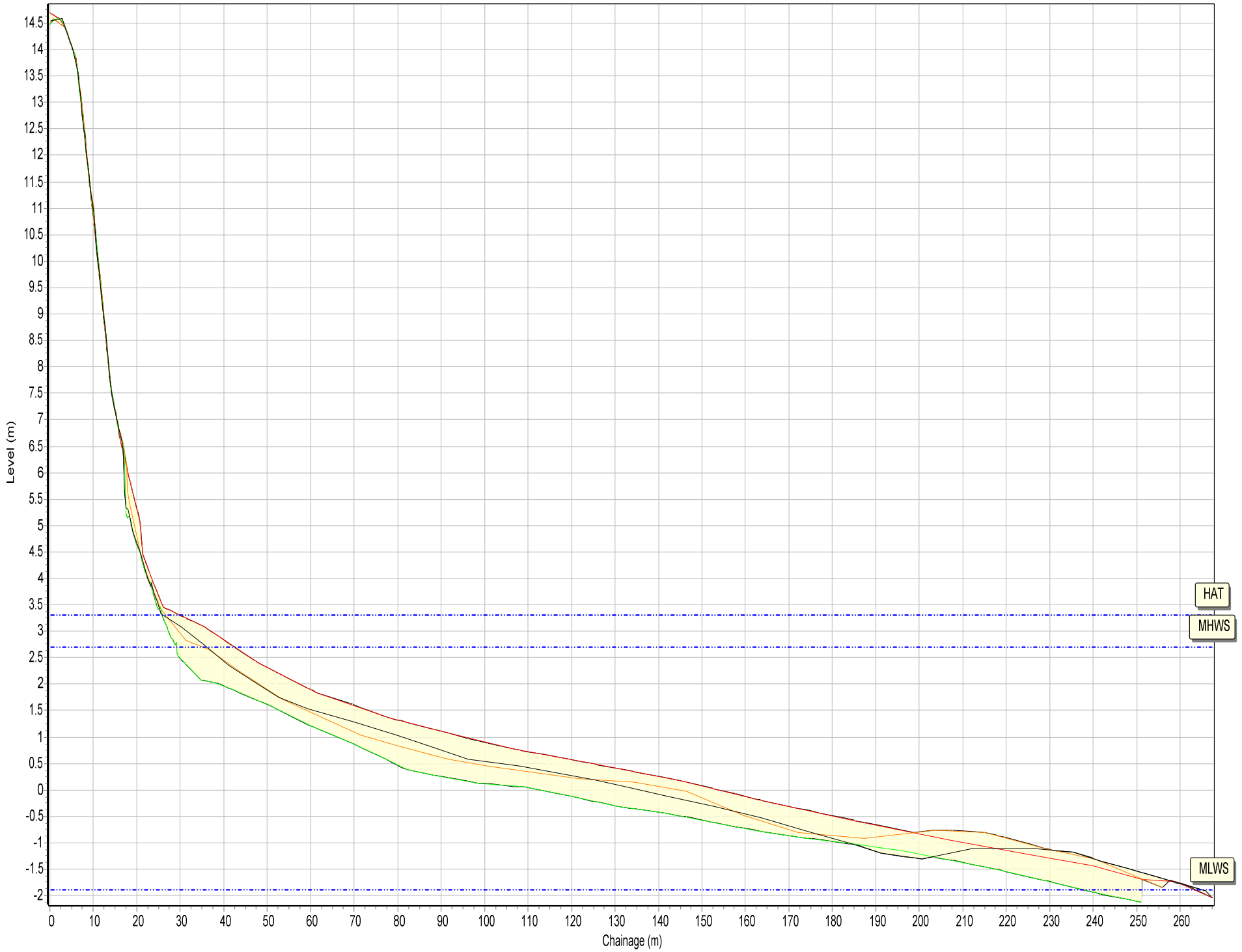
HAT

MHWS

MLWS

SANDS

Beach Profiles: 1cHN3A



Profiles Envelope  
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17/11/2017

HAT

MHWS

MLWS

SANDS

Beach Profiles: 1cHN4



Profiles Envelope  
10/11/2008  
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01/04/2017  
17/11/2017

HAT

MHWS

MLWS

SANDS



Beach Profiles: 1cHN4A



- Profiles Envelope
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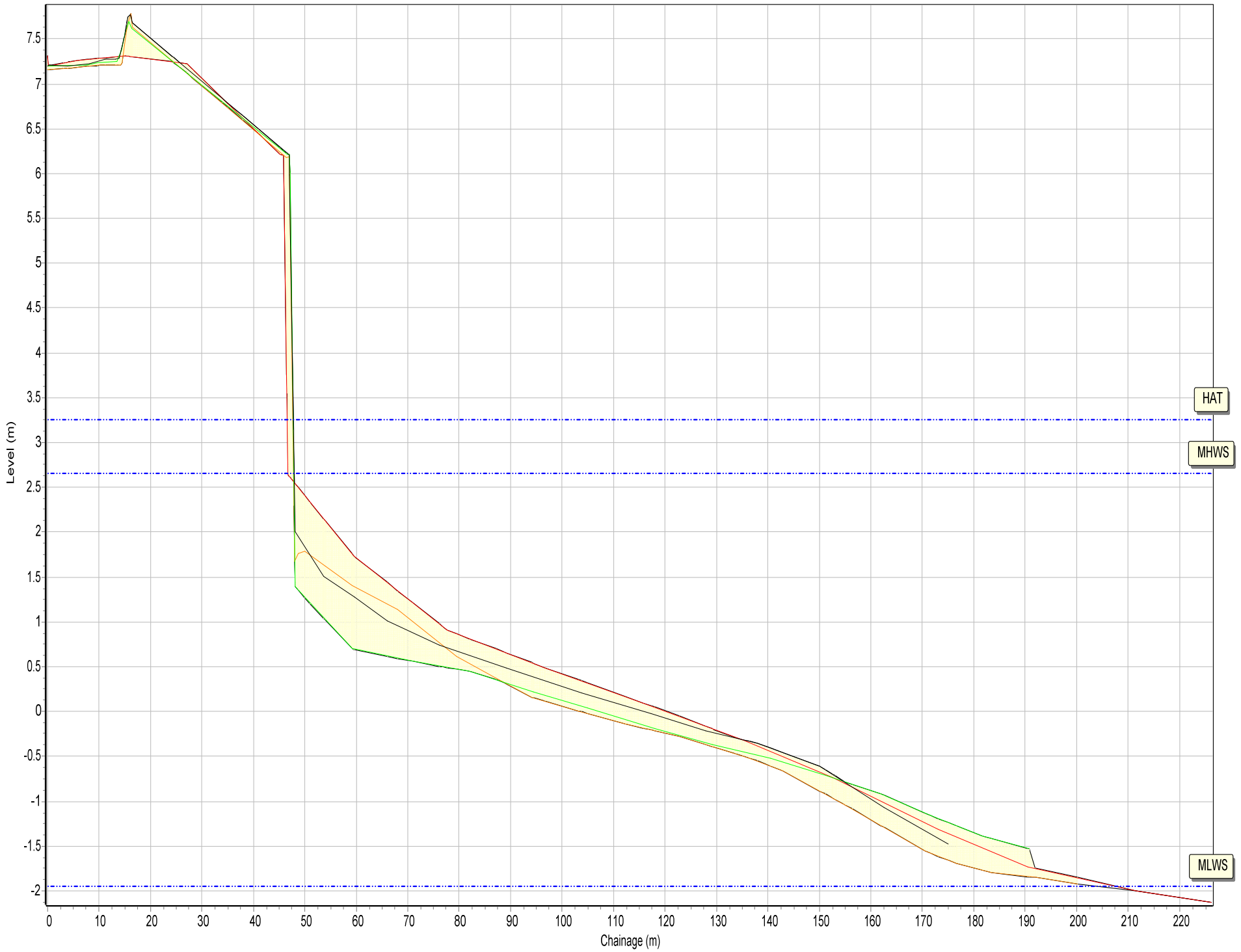
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MHWS

MLWS

SANDS

Beach Profiles: 1cHC1



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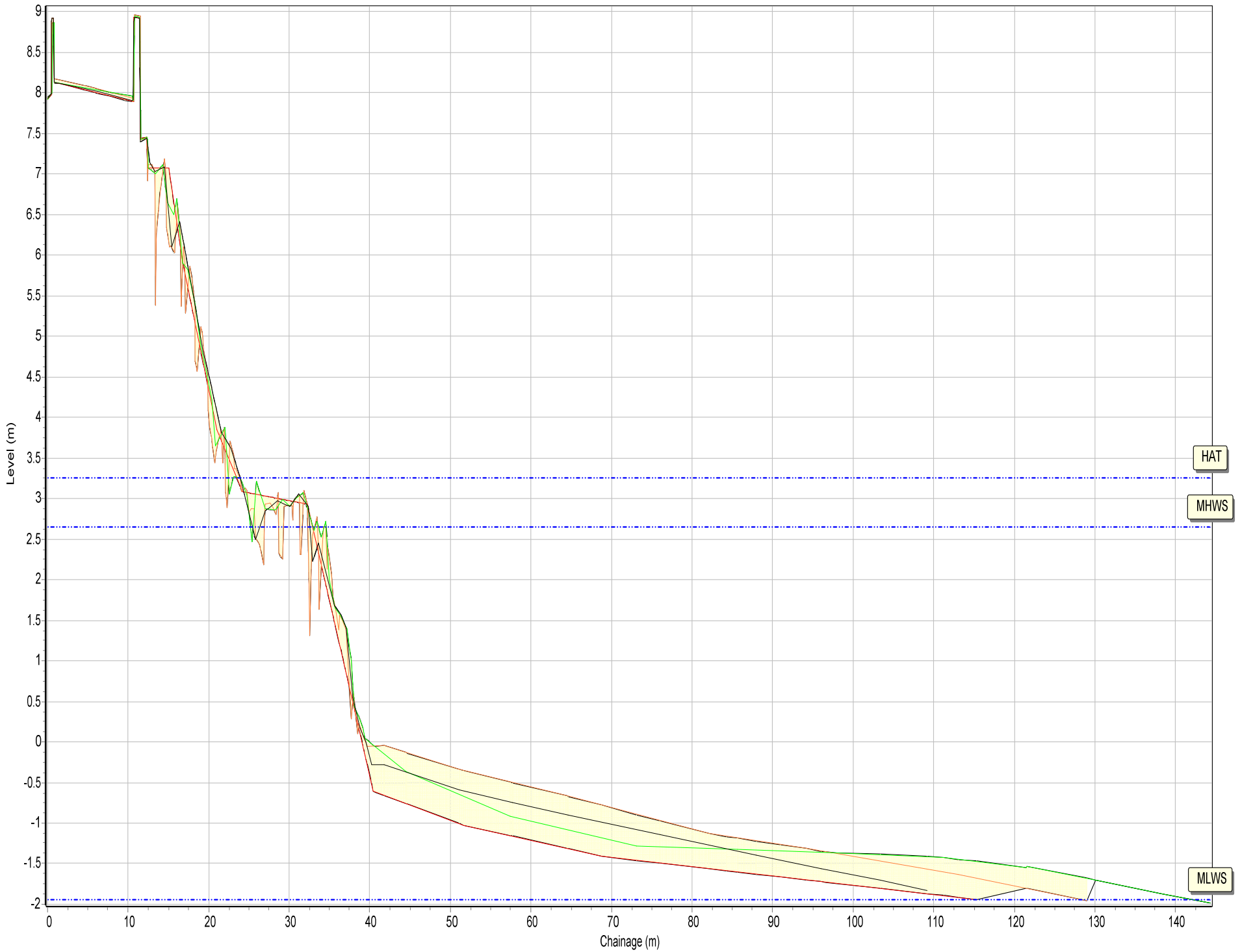
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MHS

MLWS

SANDS

Beach Profiles: 1cHS1



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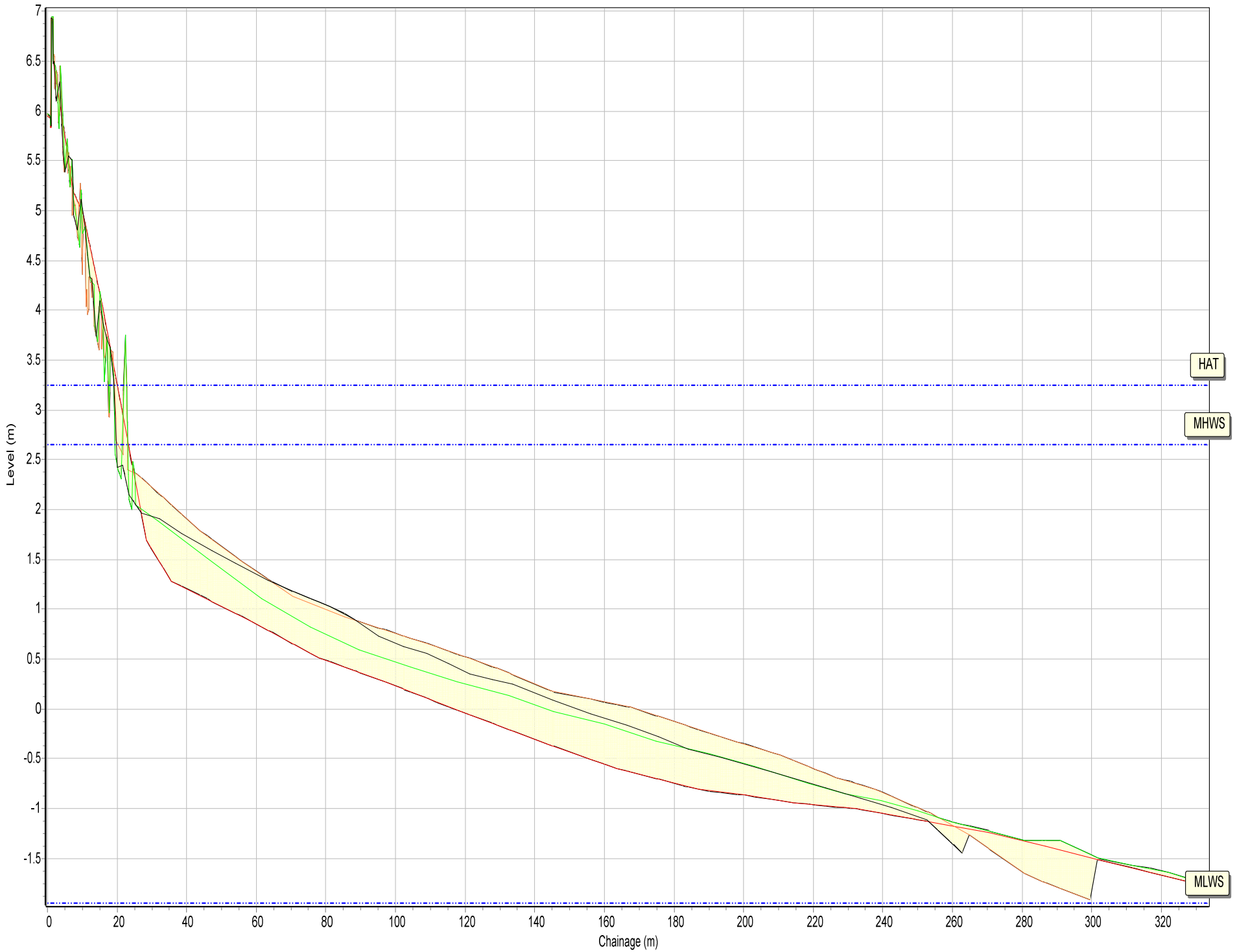
HAT

MHWS

MLWS

SANDS

Beach Profiles: 1cHS2



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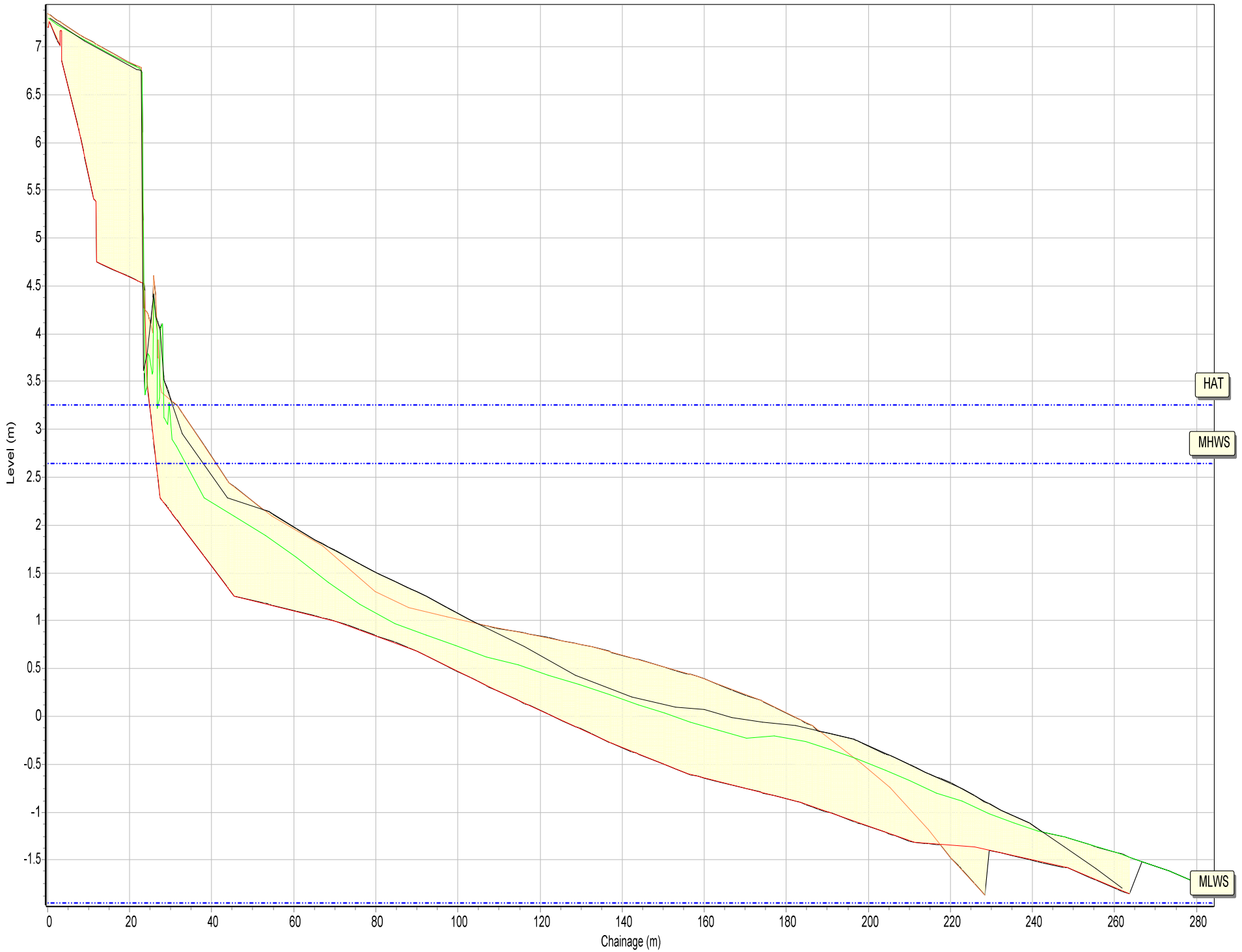
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MHWS

MLWS

SANDS

Beach Profiles: 1cHS3



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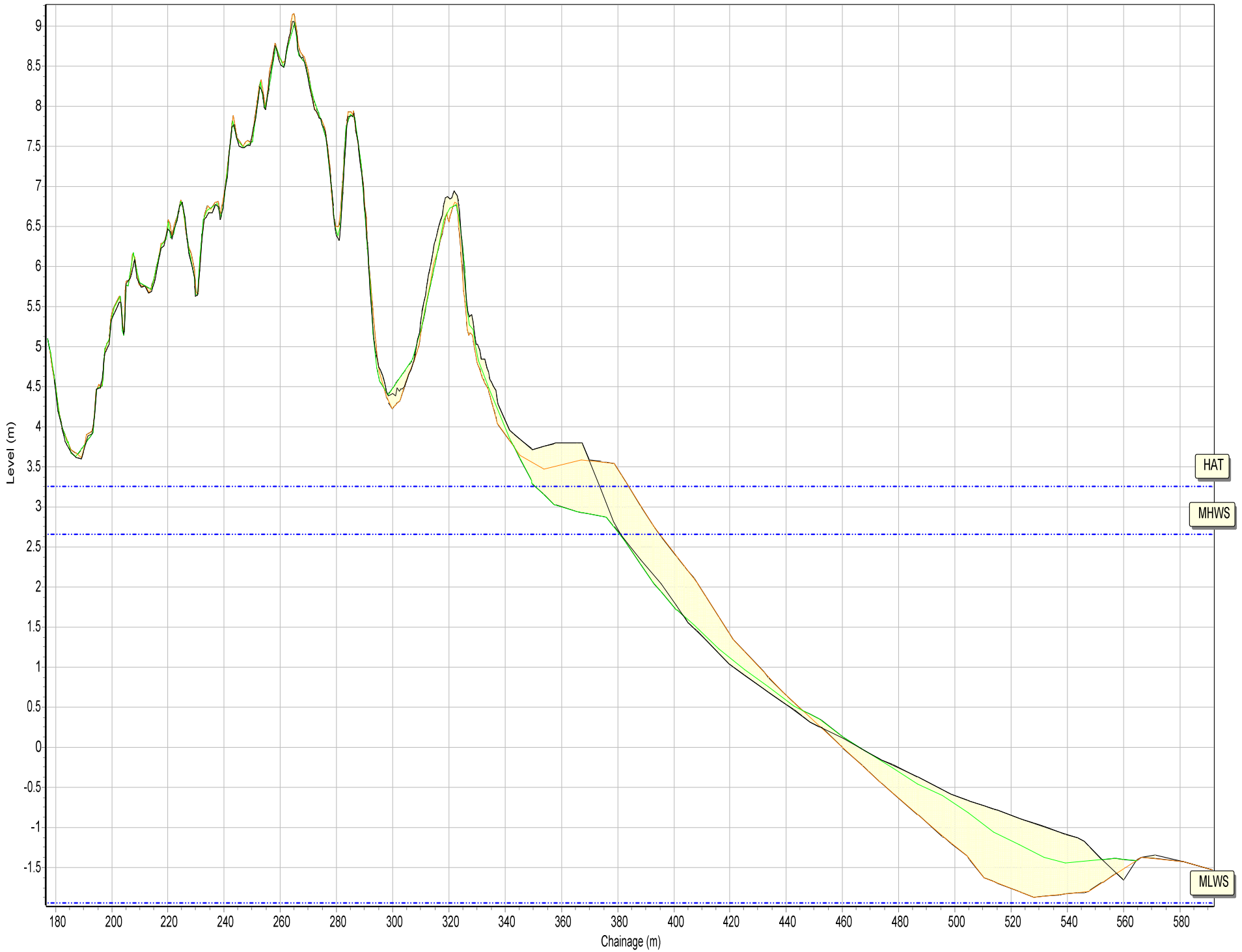
HAT

MHWS

MLWS

SANDS

Beach Profiles: 1cHS4



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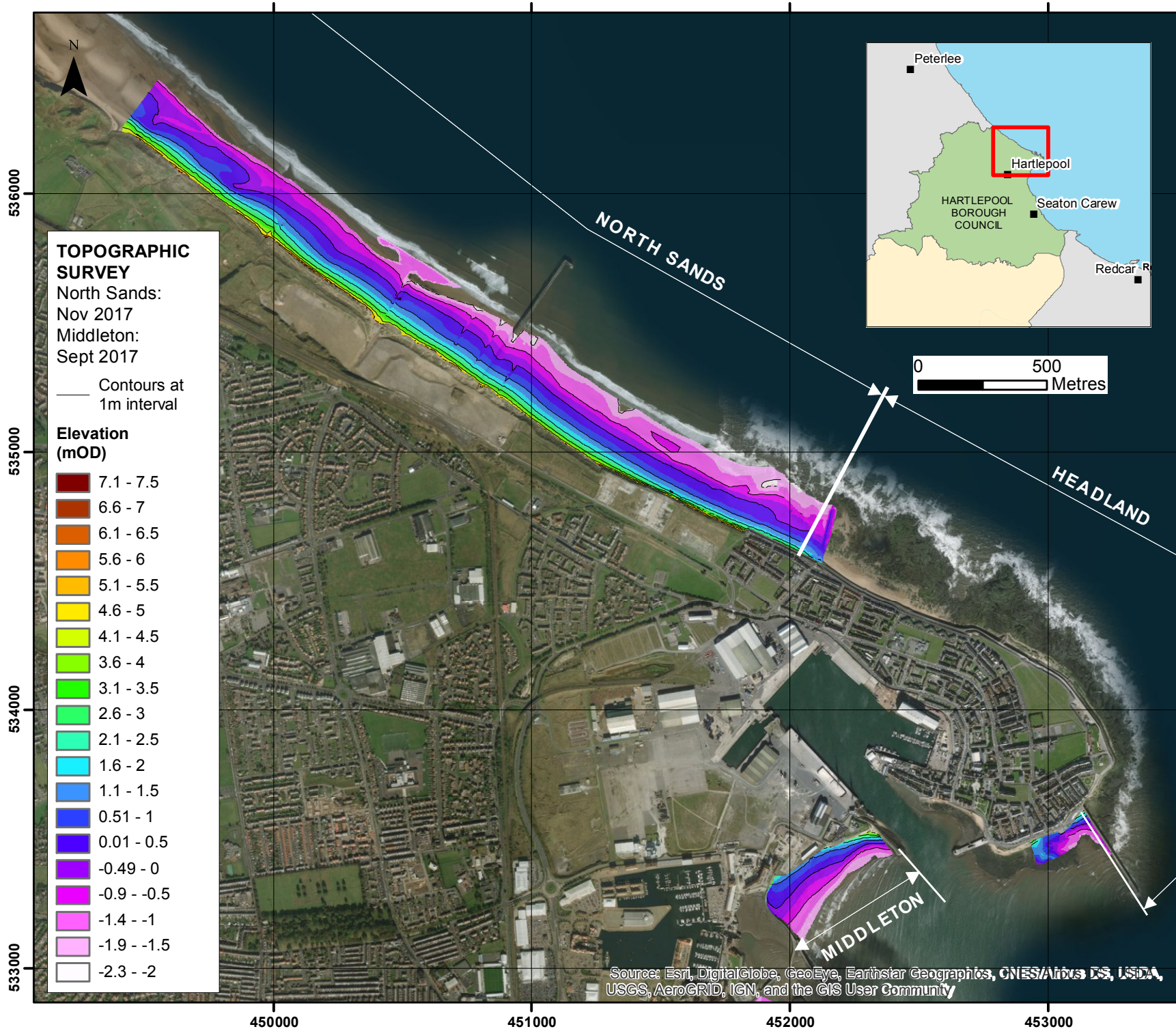
HAT

MHWS

MLWS

SANDS

**Appendix B**  
**Topographic Survey**



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Key

Client: North East Coastal Group  
 Project: Cell 1 Regional Coastal Monitoring Programme

**Appendix B - Map 1**  
**HARTLEPOOL NORTH**  
**Hartlepool Borough Council Frontage**  
 Analytical Report  
 'Full Measures' Survey 2017

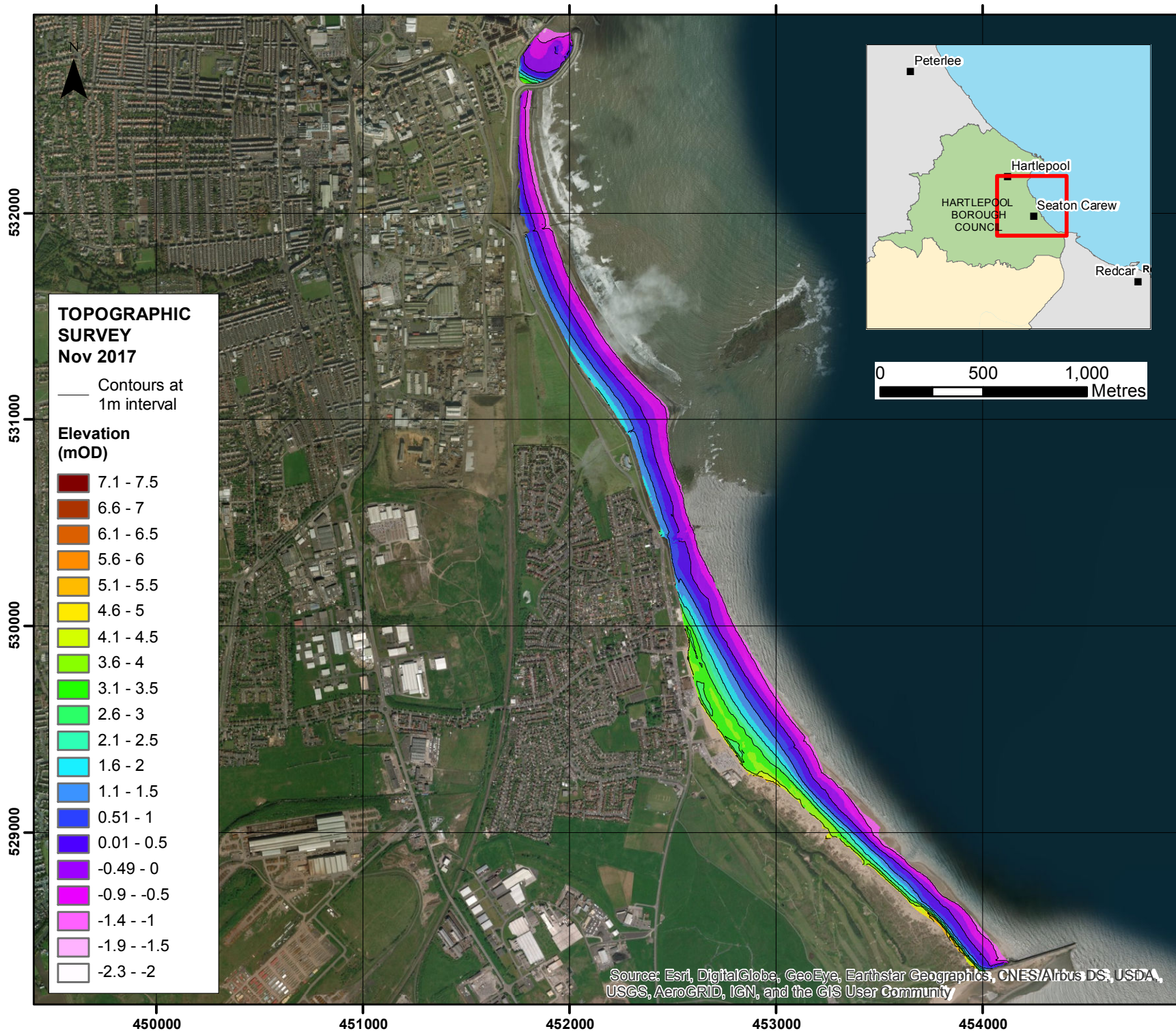
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 Royal HaskoningDHV  
 Marlborough House  
 Marlborough Crescent  
 Newcastle upon Tyne  
 NE1 4EE

Tel: +44 (0)191 211 1300  
 Fax: +44 (0)191 211 1313  
 www.royalhaskoningdhv.com





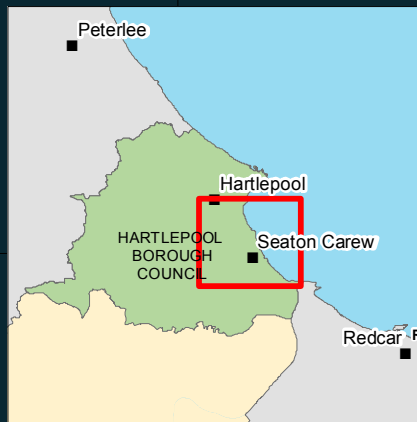


**TOPOGRAPHIC SURVEY**  
Nov 2017

— Contours at 1m interval

**Elevation (mOD)**

- 7.1 - 7.5
- 6.6 - 7
- 6.1 - 6.5
- 5.6 - 6
- 5.1 - 5.5
- 4.6 - 5
- 4.1 - 4.5
- 3.6 - 4
- 3.1 - 3.5
- 2.6 - 3
- 2.1 - 2.5
- 1.6 - 2
- 1.1 - 1.5
- 0.51 - 1
- 0.01 - 0.5
- 0.49 - 0
- 0.9 - -0.5
- 1.4 - -1
- 1.9 - -1.5
- 2.3 - -2



Key

Client: North East Coastal Group  
Project: Cell 1 Regional Coastal Monitoring Programme

**Appendix B - Map 2**  
**HARTLEPOOL SOUTH**

**Hartlepool Borough Council Frontage**

Analytical Report  
'Full Measures' Survey 2017

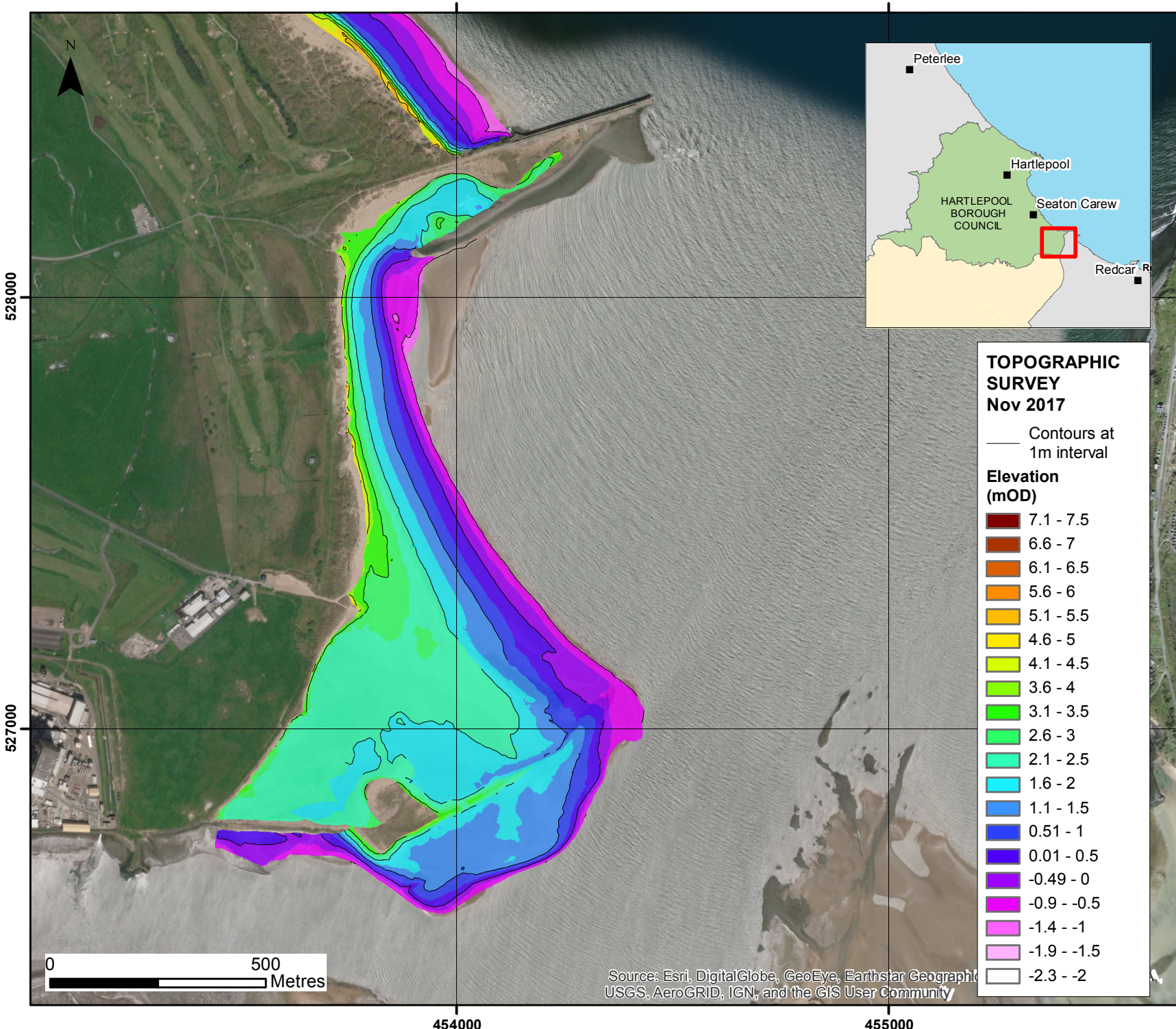
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Royal HaskoningDHV  
Marlborough House  
Marlborough Crescent  
Newcastle upon Tyne  
NE1 4EE

Tel: +44 (0)191 211 1300  
Fax: +44 (0)191 211 1313  
www.royalhaskoningdhv.com



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



**TOPOGRAPHIC SURVEY**  
**Nov 2017**

— Contours at 1m interval

**Elevation (mOD)**

7.1 - 7.5
6.6 - 7
6.1 - 6.5
5.6 - 6
5.1 - 5.5
4.6 - 5
4.1 - 4.5
3.6 - 4
3.1 - 3.5
2.6 - 3
2.1 - 2.5
1.6 - 2
1.1 - 1.5
0.51 - 1
0.01 - 0.5
-0.49 - 0
-0.9 - -0.5
-1.4 - -1
-1.9 - -1.5
-2.3 - -2

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, USGS, AeroGRID, IGN, and the GIS User Community

Key

Client: North East Coastal Group  
 Project: Cell 1 Regional Coastal Monitoring Programme

**Appendix B - Map 3**  
**HARTLEPOOL NORTH GARE**  
**Hartlepool Borough Council Frontage**

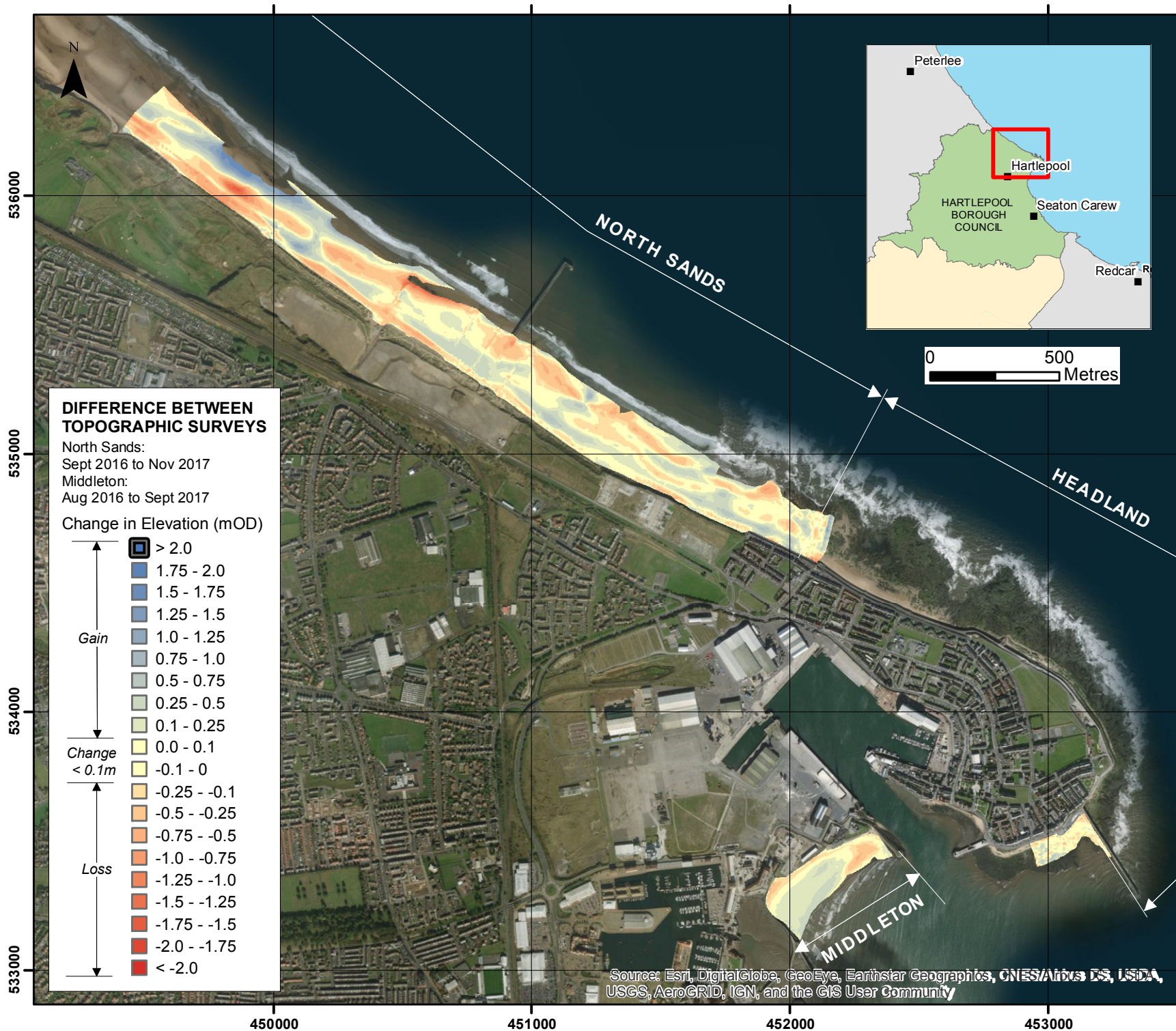
Analytical Report  
 'Full Measures' Survey 2017

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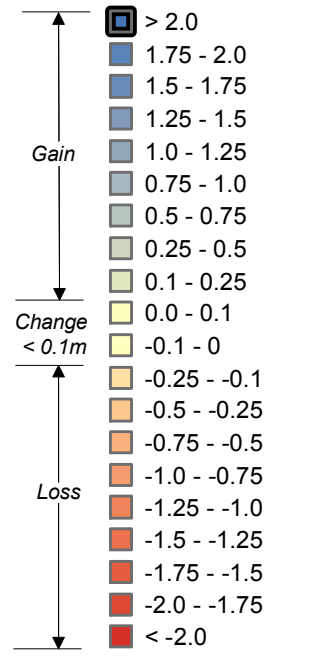
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**DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS**

North Sands:  
Sept 2016 to Nov 2017  
Middleton:  
Aug 2016 to Sept 2017  
Change in Elevation (mOD)



Key

Client: North East Coastal Group  
Project: Cell 1 Regional Coastal Monitoring Programme

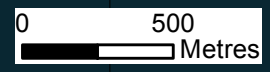
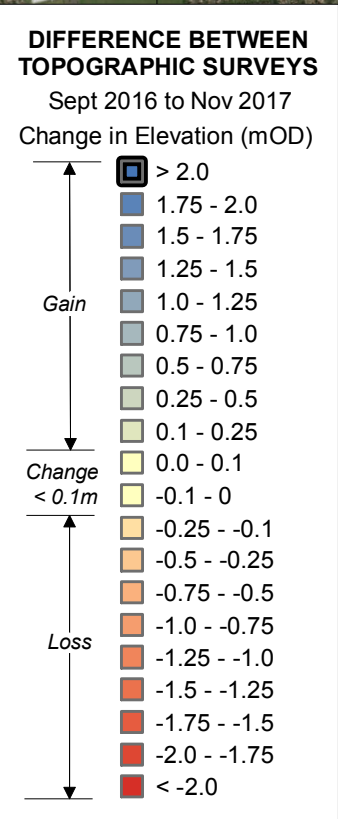
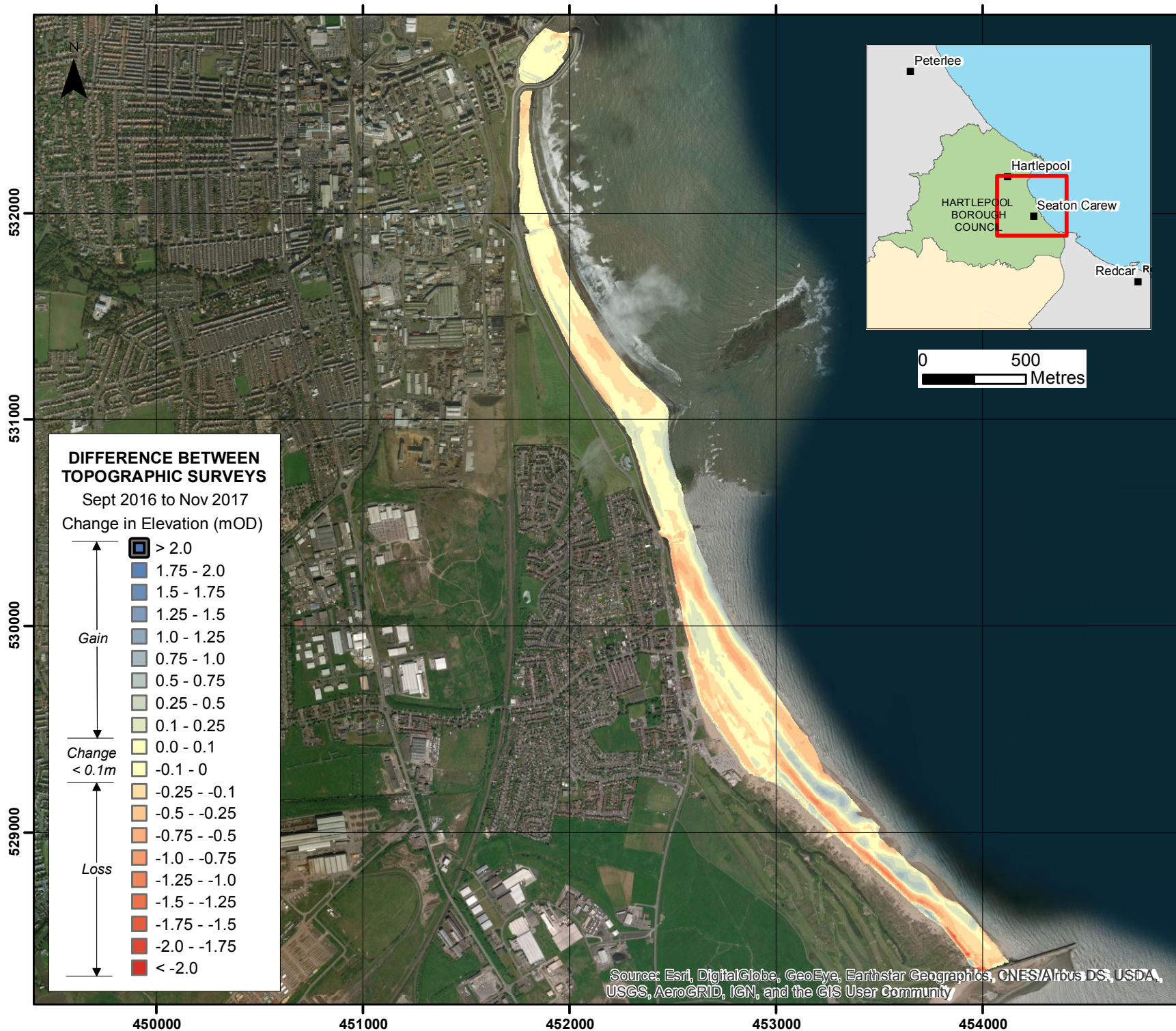
**Appendix B - Map 3**  
**HARTLEPOOL NORTH**  
**Hartlepool Borough Council Frontage**  
Analytical Report  
'Full Measures' Survey 2017

Drawing Scale at A4 1:20,000

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Royal HaskoningDHV  
Marlborough House  
Marlborough Crescent  
Newcastle upon Tyne  
NE1 4EE  
  
Tel: +44 (0)191 211 1300  
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Key

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Client: North East Coastal Group  
 Project: Cell 1 Regional Coastal Monitoring Programme

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**Appendix B - Map 5**  
**HARTLEPOOL SOUTH**

**Hartlepool Borough Council Frontage**

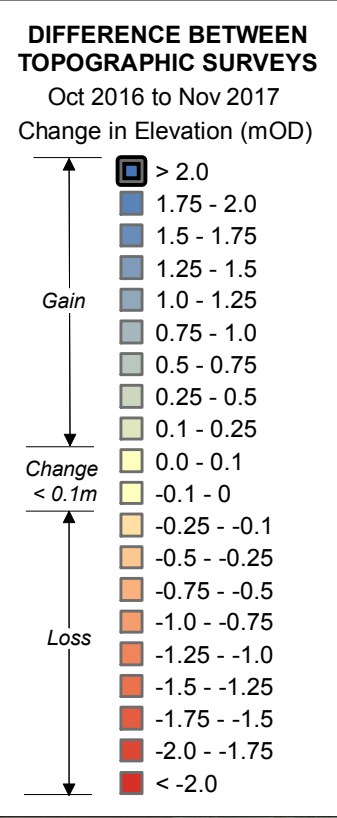
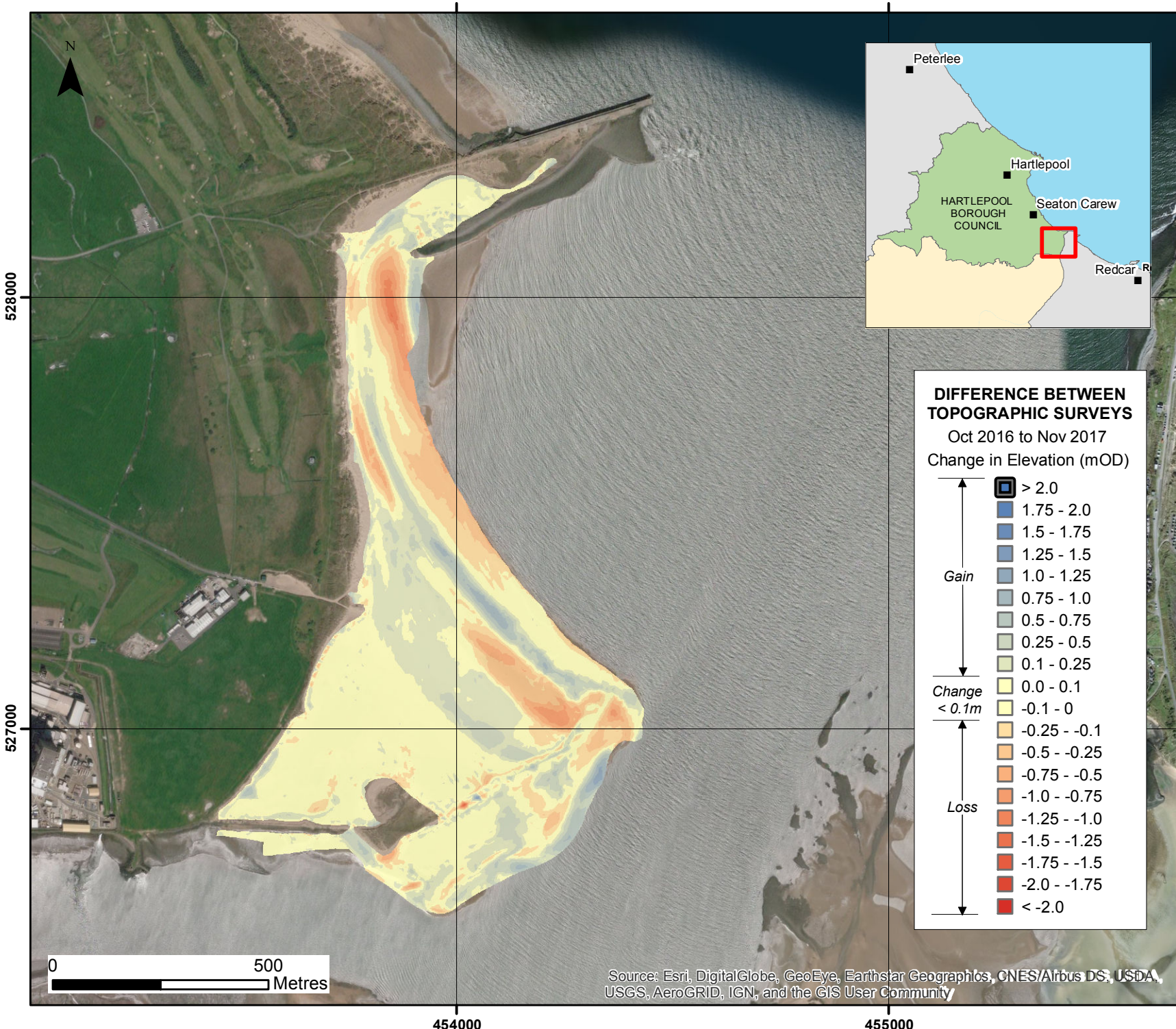
Analytical Report  
 'Full Measures' Survey 2017

Drawing Scale at A4 1:25,000

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 Royal HaskoningDHV  
 Marlborough House  
 Marlborough Crescent  
 Newcastle upon Tyne  
 NE1 4EE

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Key

Client: North East Coastal Group  
 Project: Cell 1 Regional Coastal Monitoring Programme

**Appendix B - Map 6**

**HARTLEPOOL NORTH GARE**

**Hartlepool Borough Council Frontage**

Analytical Report  
 'Full Measures' Survey 2017

Drawing Scale at A4 1:12,000

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 Marlborough Crescent  
 Newcastle upon Tyne  
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 Fax: +44 (0)191 211 1313  
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community